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MAY 1957

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We now know that, astronomically speaking, the Earth is completely insignificant and man a by-product of an infinitesimally small corner of the Universe. This certainly requires a re-orientation of man's idea of his own importance, which is very beneficial for his pride.—ARTHUR F. SMETHURST, *Modern Science and Christian Beliefs.*

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SCHOOL SCIENCE AND MATHEMATICS

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SCIENCE AND THE LANGUAGE ARTS COMPLEMENTARY SUBJECTS

SISTER M. ANNE PAULA
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One reason often given for not teaching science in the elementary school is that the curriculum is already overcrowded. "How can science be fitted in?" many teachers ask. Often they realize its importance but they do not see it in relation to other subjects. Some have not learned to capitalize on the genuine thirst children have for knowledge about the natural world, in order to improve instruction in reading, writing, and arithmetic. An important objective for elementary science is to help children use science in their everyday lives. Too much instruction in the past has been *about* science. "The real concern should be directed to science as a way of thinking and a force which may or may not contribute to social good, depending upon control."[1] Lee and Lee also state that thought is the basis of all the language arts.[2] In correlating, however, one must be careful that it be natural for if it is forced it defeats its purpose.

Science as an aid to language arts. There are four main areas in the language arts: listening, speaking, reading, and writing. What has science to contribute to each of these?

The most basic of the language arts is that of listening. Too often it is the one most poorly taught and listening instruction is merely incidental. Children are told to listen carefully but often they don't know how to listen. The science program, if well planned, offers many

[1] Lee, J. Murray, and Lee, Dorris May. *The Child and His Curriculum.* New York: Appleton-Century-Crofts, Inc., 1950. p. 483.
[2] *Ibid.*, p. 361.

excellent opportunities which will help children become better listeners.

One of the most elementary factors of listening is that of interest. We listen well if we are interested in the subject. It has been proven many times that children are vitally interested in the world about them. They seldom need further motivation, especially if the subject is one that has come out of their own experiences.

Another factor of listening, especially important when the material is more difficult, is vocabulary. If, through the use of discussion, actual experiences, and reading, there has been a gradual clarification of concepts, even small children can listen intelligently to an authority speaking on the subject of their interest.

A study of Indian life in social studies led to an interest in anthropology in a third grade room. The remains of an old Indian civilization had been discovered in the neighborhood of the school and the anthropologist in charge of the excavation was invited to tell the children about the findings. There was perfect attention for more than a half hour as he spoke on the discoveries made about the Indians who had lived there during the Stone Age. When allowed to question their speaker the third graders showed their interest in and understanding of the subject further by their intelligent questions. Yet anthropology, as such, would not be considered a subject to which third graders would normally listen.

A third factor in listening is that of purpose. Many types of listening activities having a definite purpose find their place in a good science program. How better can one learn to listen purposefully than by practice? In discussion and planning periods the children listen to find what others think. They learn to relate what they hear to their ideas. Listening to the various sounds of nature is another type of purposeful activity which combines the two areas. Still another would be listening to reports from several sources to compare the facts given.

Radio and TV science programs can be a listening activity. There are now many good programs of such nature on TV. Some schools have even developed an in-school viewing of science programs. Others use programs assigned for home listening as a jumping-off place for classroom science. In any event there is real listening because it is purposeful.

Speaking, the second area of the language arts, is one closely related to listening. The science planning and discussion periods lend much to thoughtful speech. As was mentioned earlier, thinking is basic to all the language arts. In defining a problem, suggesting hypotheses, and drawing up conclusions, children are learning to think before speaking. Yet science material is of such universal interest that in an

atmosphere where all are working together for a solution there is a feeling of freedom. Even the most timid can be encouraged to give suggestions.

Formal and planned speaking activities also follow naturally in a good science program. Reports of experiments must be made to the class. Books read on various subjects need to be reported upon. Again when interest is high, effort tends to reach the maximum.

Children are no longer expected to learn all types of reading in the reading class itself. Reading science books is a separate skill. Children need to learn how to read and how to interpret science materials. This should have a carry-over into the other reading activities of the school program.

Often science books are the answer to remedial reading problems. In working with two sixth grade boys in a remedial reading clinic, the author found that an easy book about dinosaurs was the one that finally made reading of interest to them. Reading became purposeful because the boys found that they could read about something that really was important and interesting to them.

Burnett emphasizes this point. He claims that many children do not learn to read because they find no motivating interest in the types of beginning readers we have today.[3] Even though there are many good primary science books, this point of using them for motivating interest in reading needs to be stressed.

There are also many opportunities in science for purposeful activities in writing. Writing up reports, sending for materials, and even creative writing have their place in the science program.

Many writing activities took place in a third grade room as a result of a field trip made to study the plant life in a rocky area near the school. The main interest turned out to be completely different from that planned. It was a lizard which was caught by one of the boys and brought to the classroom for a pet. Reports of the trip were exciting things to write because so much had happened. Then after a terrarium was made for the lizard's home, an explanatory paragraph was found necessary for the many visitors who came to see this special pet. This was carefully planned by the group and lettered neatly so it could be placed near the terrarium for all to see.

Reports of the lizard's activities found a place in most letters written to former teachers or to classmates who were absent. When the lizard, appropriately named "Long Tail," lost his long tail, another whole area of interest was aroused. It inspired much creative writing because of the problem of the name. It was unanimously decided that he should be "Short Tail" until his tail lengthened.

[3] Burnett, R. Will. "Reading and Plugging in through Elementary Science." *The Science Teacher*, 21: 66, March, 1954.

These are only a few possibilities of how science can bring interest and enthusiasm to the language arts. Of themselves the language arts are of no value for there must be something to communicate. Why not use the opportunities science provides for better learning in the language arts?

Language arts as an aid to science. Correlation can also be considered from the opposite point of view. Language arts are very important in the development of science projects of many kinds. Most science centers around problem solving. Each of the steps of problem solving involves many types of language activities and skill in these areas is important if the science project is to be a success.

Books can be very valuable in stimulating interest in various fields of science. Too often they are used in an attempt to satisfy the child with the easiest way of answering his questions. They should be a means of stimulation and one that will lead to further action. Several good bibliographies of science books for children are available that will be of great value in choosing books.[4]

Once interest has been stimulated in some field, either through actual experiences or through books, there is need of unhurried introductory sessions for planning. If children have set standards for their discussions these will be of great value in the planning period. They will have learned that they must take turns speaking. They will know the importance of listening to each speaker. If they are properly guided they will be able to define their own problem, decide on possible solutions, and make their plans for going ahead with the project. All this takes into consideration many of the skills of listening and speaking.

Children have many qualities in common with research workers. They are curious about much which does not interest ordinary adults. They notice different things. Their imaginations know no bounds. Discovery to them brings untold joy. These are characteristics of research workers and should be cultivated in children.[5] They should be encouraged to work out their own hypotheses even though they be found wrong. In solving science problems one expects to make mistakes and therefore the fear which frequently stifles children's work is eliminated.

This research will involve many other language activities. Skill in writing is needed to make written reports of experiments and field trips. One must know the proper form for letter-writing in order to

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[4] Association for Childhood Education. *A Bibliography of Books for Children.* 1954. The science section was prepared under the direction of Dr. Herbert S. Zim.

Kambly, Paul F. and Piper, Evelyn. "The Elementary School Science Library for 1954–1955." SCHOOL SCIENCE AND MATHEMATICS, 56: 308–15, April, 1956. A list published in this magazine each year.

[5] Meder, Elsa Marie. "Problem Solving for Today's Children." *Science Education*, 36: 131–34, April, 1952,

send for information or to invite an authority in the field to speak to the class. Reading of many types is involved in searching for information and for verifying the children's own discoveries.

Because of this need for reading in research there should be a wide variety of science books available to the children. They should be close at hand when a child or a group becomes involved in a certain problem. Small children, especially, are incapable of doing extensive research work outside of the classroom or the school library.

If older children have learned the basic format of books it will be greatly to their advantage in problem solving. They should know, for instance, the importance of information found on the title page. They should know how to find out about the author and his sources of information. Knowledge of the copyright date and what it implies helps them in finding the most recent information. They need skill in many techniques such as using the table of contents, the index, the appendix, maps, and charts. Even an appreciation for the preface, the foreword, and the list of acknowledgements should be taught the older child.

The materials found in the research must then be organized. This involves simple outlining. The report, whether oral or written, must be carefully planned. The child must know how to reorganize the material into his own words. He must realize that in order to share it with others he must first make it his own.

Evaluation of the project is another science activity which involves discussion. As the children talk over their work they discover how they could improve. They find that they have made real progress and are encouraged to delve further into the problem or into another related one.

Many other language arts skills can be used to advantage in science. The science bulletin board is an excellent way of summarizing findings and stimulating the interest of others. Children must know how to write up their material so that just enough is given to create interest or to give a brief but accurate account of their work. Even dramatics can be used to make science instruction more effective.

From the few examples given above, one can readily see that the language arts also contribute much to science. Skills in all the language arts are necessary to a good science program.

Much more could be written about the contributions science and the language arts make to one another. Every class has different needs at different times but each will profit from correlation. Teachers who feel that their program is too croweded to teach science are losing out on one of the most valuable means of motivating the arts of communication. They are also missing an excellent opportunity to help their pupils learn to think.

HETEROGENEOUS IDEAS FOR INTERESTING DISCUSSION II

JULIUS SUMNER MILLER
El Camino College, El Camino College, California

We continue this new adventure with another series of inviting inquiries.

1. Examine the behavior of a body in free fall (near the earth)· Discover the following for a body falling from rest:
   (a) The distances passed over *during* successive seconds are in the ratio of the successive *odd* numbers beginning with one.
   (b) The distances passed over measured from rest are in the ratio of the *squares* of the successive integers beginning with one.

2. A wheel rolls along a horizontal road. Is there a point which has a velocity straight *up* or *down?*

3. A piece of mud leaves the hindmost part of a rolling wheel. Will it hit the wheel again?

4. Monument workers engrave stones by sand-blasting. They first cover the face of the stone with a rubber sheet ($\frac{1}{4}''$ or so thick) and cut out the letters or design in the rubber. The sand-blasting then cuts out the stone where it is exposed but does not cut away the rubber. Explain this in good physics.

5. Consider a horizontal angle-iron track with one end inclined. On the horizontal track rests an array of billiard balls. If one is taken up the plane and released it rolls down, strikes the system at rest, and *one* ball rolls away from the far end. We say $mv=mv$. Now if two are released we find two going away. We say $2mv=2mv$. This is all on the strength of momentum conservation. But why in the second case cannot *one* go away with a velocity $2v$? We would then have $2mv=m(2v)$.

6. Two men A and B of identical weights hold the ends of a rope which passes over a frictionless pulley. A climbs up. What happens to B?

7. Consider the following problem: *A column of troops 3 miles in depth marches along a road. An officer rides at a uniform rate from the rear of the column to the head, and back again at once, reaching the rear of the column just as an advance of 4 miles has been made. How far did the officer ride?* A student submits the following solution: "If 4 miles was advanced by the army while the officer traveled *up* and *back*, 2 miles was advanced while the officer traveled *up*. Therefore, the officer traveled 3 miles+2 miles+3 miles=8 miles." Now 8 miles is the correct answer but is the logic of the solution acceptable? It is not uncommon in physics to find answers which are gotten by physically wrong means.

ENRICHMENT AS A PROVISION FOR THE GIFTED IN MATHEMATICS

MONTE S. NORTON
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Probably one of the best and most adaptive methods of providing for the gifted pupil in mathematics is through enrichment. Enrichment, if adapted to each individual student rather than the group, is excellent for developing interest, initiative, insight, and other valued phases of learning connected with work in mathematics. Usually, enrichment implies supplementary educational experiences used for the optimum development of each pupil. The true enrichment process does not include merely the addition of extra work for the pupil concerned, but aims to enrich the pupil's entire learning process.

> "To be enriching in the best sense, the added work should be integrated with the general curriculum. . . . Too frequently enrichment has been assumed to result from casual museum trips, a foreign language taken for a semester or two in the early grades and then dropped, turning on the television for some national or political event, answering the telephone for the principal, helping the teacher with her records. . . . The line between enrichment and busy-work is sometimes a thin one. . . . Enrichment may be provided in any class anywhere. There is no school so small, no community so isolated, that opportunities do not exist. . . . Enrichment should be provided for all children who can profit from it whatever type of program they are in."[1]

Undoubtedly, the practice of assigning additional work or more difficult problems to the more capable pupils in mathematics classes is universal. Although extra-credit is sometimes given to those students who complete the extra work, these assignments are all too frequently given merely to keep rapid learners occupied for the full classroom period. As one mathematics teacher stated: "They can call it busy work if they want to, but the extra problems I assign sure help to keep those 'fast brains' out of my hair." Supplementary problems certainly have a place in any enrichment plan, but should serve as only one device for making the program effective.

Fortunately, there are many administrators and teachers in our public schools who are vitally interested and concerned about the gifted-pupil program in their school. Many of the people involved with the current problem of providing for the gifted pupil in mathematics appear to be in need of specific suggestions for providing for the gifted pupils in their charge; techniques, devices, activities, and other experiences that have been successfully administered and that have produced successful results. Some suggested enrichment activities for the gifted pupil in mathematics that this writer has found

[1] D. A. Worcester, *The Education of Children of Above-Average Mentality*, University of Nebraska Press, Lincoln, Nebraska, 1955, pp. 39–42.

educationally successful in working with the gifted pupil are as follows:

1. Reading and Writing Activities

"The read and write method can provide many worthwhile opportunities for the talented to develop their potentials in science and mathematics. . . . The material should be within the ability of the student, but challenging."[2]

One specific example of this type of activity is illustrated by the technique used by this writer in the public schools in Lincoln, Nebraska. Students were asked to select readings from several books, pamphlets, and magazines that were on hand for supplementary use. Through cooperative planning and effort, the readings were condensed into a report-type paper and published in a special school newspaper entitled ***Math News***. The mathematics newspaper was then distributed to all the mathematics pupils in the school so that they too could benefit from the important material and articles in the paper. Some of the articles were titled "Why Study Math?" "Math for College Preparation," "Tips for Doing Homework in Mathematics," "Math and Engineering," and "Mathematics in the Military Service." Of course, activities in the area of writing and reading are practically inexhaustible. Teachers should select activities in this area that are best suited to the individuals or individual involved and encourage each pupil to work on various projects of his own initiative.

2. Individual and Group Projects in Mathematics

Mathematical projects, whether individual or cooperative in nature, should be designed so as to make some worthy contribution to the classes' goals and purposes. One such activity might be the development of a film showing the application of geometry in life as was done by a mathematics class in Blair, Nebraska. Another excellent activity in this area is illustrated by the Math Fair held at Omaha Benson High School in Omaha, Nebraska. In this activity, capable pupils in mathematics classes worked on specific projects which were later displayed or used in the Math Fair conducted under the supervision of the supervisor of mathematics. A group project used by this writer in a unit on mathematics and measurement involved the accumulation of over 175 measuring devices such as the micrometer, transit, vernier caliper, feeler gauge, inside and outside calipers, sextant, and various meters. Each instrument was discussed in regard to its use, connection with mathematics, and contribution to our unit on measurement. It was estimated that over 1800 people

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[2] U. S. Department of Health, Education, and Welfare, Bulletin 1952, No. 15, Washington, D. C., p. 10.

visited the classroom to see the instrument display; photographs of the exhibit were used on local television programs and for showing during Education Week in Lincoln, Nebraska.

3. Additional Exercises and Supplementary Problems

One of the most common practices is to assign additional problems to the gifted pupil in mathematics. This technique is frequently overworked and when used for "busy-work" this device usually produces negative rather than positive results. If such problems and assignments are assigned intelligently, they may be of great value in developing further interest and insight in mathematics for the gifted pupil. The pupil may be asked to do special reading, answer a specific question about the history of mathematics or perhaps to investigate some area of mathematics he is most interested in and give a report to the teacher or the entire class. At University High School in Lincoln, Nebraska, gifted students frequently are given specially designed units in mathematics on such topics as "Number Systems," "Other Geometries," "Vectors," "Rate of Change," and "Chance." These units are designed to be self-teaching and are complete with explanations, illustrations, and exercises for the pupil to work. The purpose of each unit is to further the students' understanding and interest in mathematics.

4. Building Vocabulary in Mathematics

The building of a vocabulary in mathematics, that is, the learning of words and meanings peculiar to the field of mathematics, is often neglected, but is extremely important to the student mathematically inclined. This provision may be made through the development of special units concerned with vocabulary building in mathematics. Many excellent teaching guides, textbooks, and resource units are available which may be of great value to the teacher concerned with improving the mathematical vocabulary of pupils under her charge.

5. Applications of Mathematics

Many educators see the idea of application as the best method for stimulating interest in mathematics for the gifted pupil. Frequently, such worth-while books as *Math Is Fun*, *Math for the Millions*, *Mathematical Wrinkles*, and *Mathematics in Western Culture* are used for developing student interest and insight in mathematics. Whenever possible, authorities suggest that the teacher emphasize various applications of mathematics as used in the technical world of today. Mathematics as used in engineering, topography, cartography, actuarial work, business, science, farming, metal work, electronics, and many other facets of life should be brought to the attention of

the pupil whenever such material may contribute to the best interest and understanding of the individual concerned.

Administrators and supervisors can be of great service to the teacher in this area by helping in every way to obtain special material for the teachers' and pupils' use. One of the most valuable aids in the area of application of mathematics, in the experience of this writer, is a well-developed resource unit for the particular course at hand. Naturally, the teacher will have many ideas of her own in regard to her particular class and its application in life, but a well-developed, well-written, and comprehensive resource unit can be an invaluable aid to the teacher as a guide and teaching source. Many such resource units for the teaching of the gifted mathematics pupil have been developed and are readily available to any school.

6. Mathematical Assemblies

Many administrators are encouraging teachers and pupils to work out school programs in mathematics for presentation to the entire school or to those specifically interested in mathematics. An example of such a program is illustrated by an assembly program presented by a school in Lincoln, Nebraska; planned and directed by this writer. The assembly featured a guest speaker from the University of Nebraska who spoke on the topic, "Your Opportunities in Mathematics." The talk was not on the order of a straight lecture; all pupils were asked to participate in the program in one way or another. The idea that "math is fun" was clearly illustrated with special emphasis on mathematical puzzles and illustrations. Administrators, teachers, and pupils attending this assembly felt it a huge success and expressed that the affair had helped to develop greater interest and curiosity in mathematical pursuits for the pupils. The same school is preparing for another assembly to be held in the future which will feature various demonstrations and uses of I.B.M. calculators and other business machines. Teachers and administrators, of course, should be able to think of may other possibilities in the area of mathematical assemblies.

7. Mathematical Clubs and Organizations

> "Math Clubs are often of great value in drawing out the ability and interest of students. The opportunity to participate in a lively math club, to discuss with others some of the many interesting side topics in mathematics can do much to whet the appetite and stir the interest of the gifted student."[3]

The math club in many cases meets during the regular school day. In other instances, the club may meet in the home of one of the members, the faculty representative, or at the school after school is

[3] M. H. Ahrendt, "Education of the Mathematically Gifted," *Phi Delta Kappan*, Vol. 37, No. 7, April 1953, p. 287.

dismissed. The club may be considered as a curricular or extra-curricular function depending on how it is handled. Special speakers, problems, units of study, experiments, demonstrations, discussions, projects for constructing audio-visual aids in mathematics, study of advanced areas in mathematics, and special field trips are a few of the activities of such a club. Such clubs provide excellent opportunities for talented pupils in mathematics to do research and study in special areas of interest to them and to exchange ideas and opinions with other individuals interested in mathematical pursuits.

It would be practically impossible to exhaust all of the possibilities in the area of enrichment for the gifted pupil in mathematics. Besides the suggested activities for enrichment purposes already mentioned, other activities might include the following:

1. Field trips for the specific purpose of seeing mathematics in action.
2. Class oral reports on specific topics in mathematics.
3. Activities which are designed to develop research techniques in mathematics and use of the library.
4. Collections.
5. Study and use of special units in such areas as the binary system, pi, probability, vectors, elementary calculus, men of mathematics, and other valuable areas.
6. Using gifted pupils as teaching assistants.
7. Making displays or models to illustrate a mathematical concept.
8. Writing a special unit on some phase of advanced mathematics.
9. A study of the mathematical applications of the parabola, hyperbola, ellipse, and other geometrical figures.
10. Encourage gifted pupils to enter math contests, fairs, panels, and general discussions.
11. Encourage reading on the pupil's own initiative in mathematics.
12. Provide activities which give experiences in creative expression.
13. Provide correspondence work for those interested in studying areas of mathematics not offered by the school.
14. Encourage experimentation and curiosity.
15. Familiarize gifted pupils with opportunities available to them in mathematical fields.

"The gifted pupil's program is truly enriched not by simply adding aesthetic and appreciational experiences, or by putting in an extra subject or two such as algebra or science, but through setting up a unified type of program which provides to the fullest extent for meaningful experiences in a rich environment."[4]

John Edward Bentley in his book, *Superior Children*, lists the following principles that should be considered for the best interests of gifted children in regard to the enrichment program:

Physical factors basic to enrichment:

1. Sound health should be a prerequisite for the specific modification of the gifted child's educational activities and a basis for admission to all specially organized classes or groups.
2. Activities should be provided that will yield physical capital throughout the years of the child's intellectual productivity.

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[4] Gertrude Howell Hildreth, *Educating Gifted Children*, New York: Harper and Brothers, 1952, p. 262.

Mental factors basic to enrichment:

1. Sound selection of gifted pupils should be made by means of mental tests and confirmed by pupil achievement and performance.
2. Pupils should show that they have a rich associative background.
3. High standards should be set for the bright pupils in tasks that demand the use of the psychological traits such as memory and thought.
4. Bright pupils should be given every chance to do their own thinking.
5. To develop a wholesome, integrated personality, the very bright pupil should be given the benefits of varied growth through the exercise of his several superior-behavior traits, and by providing opportunities for wide mental experiences.
6. Personality training should be stressed from the standpoint of a well-balanced mind.

Social factors basic to enrichment:

1. The gifted child should be recognized as an individual part of the social whole in order to insure social solidarity. Both individual and the group thereby have recognized rights and obligations.
2. Discipline should not be emphasized; it should be explicit.
3. Training should be always positive, constructive, and creative.
4. The standards of society should be seen in every task that the child does, however insignificant it may be deemed.
5. Superior children should be encouraged to give more of their ability and talent, since they have greater investments of mind and power.
6. Gifted children should be developed to the point of fullest social expression the interests of human service.
7. Special interests should not be neglected in the social realm. These interests will instill a sense of interdependence and create a recognition of responsibility which will enlarge the frontiers of common life.
8. The cultivation of a socialized viewpoint will counteract the errors of egoism. Gifted children will thus adjust themselves to the demands of a civilized world and at the same time grow as individuals.

Educational factors basic to enrichment:

1. Curricula adjustments should be made on the basis of educational achievement.
2. The curriculum must be seen as a series of purposive experiences; each effectively pursued will carry the individual to new heights and wider horizons.
3. The enrichment of the curriculum develops the habits of thinking, judging, through the stimulation of the higher categories of mind.
4. Enrichment data should grow out of the individual pupil's need. It should be varied, contain much explanatory material, and provide activity that will stimulate the intellectual urge and furnish emotional satisfactions.
5. Enrichment should begin early in the child's life, as soon as giftedness is noted, and thus avoid the development of unwholesome habits of work.
6. Enrichment studies should be scattered throughout the entire program of the child and not be isolated or limited to special periods.
7. Gifted children should be encouraged to use the school library, under supervision, as soon as possible. Wide reading is important.
8. Monotony of studies and needless routine should be strenuously avoided in the gifted child's program.
9. Excursions, visits and field trips are vital sources for the supply of enrichment data.
10. Anticipated higher levels of education should not be focal in the mind of the teacher or pupil; emphasis should be placed on the present tasks.
11. The teacher of superior children should be also superior in physical, and

mental endowments, and possess a broad educational and social background.

12. A cultural environment should be provided so that achievement and talent may develop and appreciation of human living duly manifested.[5]

[5] John Edward Bentley, *Superior Children*, W. W. Norton and Co. Inc., New York, 1937, p. 168.

A MODERN LOOK AT THE CONSERVATION LAWS

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Around 1900 if we wanted to cite an example of a very exact scientific law in chemistry, we usually referred to the law of conservation of matter. Similarly in physics we cited the law of conservation of energy. Even after Einstein first stated the matter-energy mathematical relationship in 1905, we continued to use the above as examples of exact laws of nature.

Let us now rethink these laws in terms of a very common chemical reaction, namely, the burning of phosphorus.

$$P_4+5O_2 \rightarrow P_4O_{10}+\text{heat}$$

Lavoisier back in 1785 could have used the fact that (4×31) or 124 grams of phosphorus would combine with 160 grams of oxygen to yield 284 grams of phosphorus pentoxide as an example of the law of conservation of matter. Today we know that the P_4O_{10} weighs slightly less than the sum of the original oxygen and the original phosphorus. It is possible to calculate the difference in terms of the energy produced. The heat evolved when we burn 128 grams of yellow phosphorus is approximately 740,000 small calories.

Now let us turn to the Einstein equation:

(A) $E=MC^2$, where $E=$ energy in ergs; $M=$ mass in grams;

$C=$ speed of light $=3\times 10^{10}$ cm/sec.

If we now imagine one gram of matter suddenly disappearing and going over to form energy we will observe that by substituting in the formula we have 9×10^{20} ergs of energy formed.

(B) $E(\text{ergs})=1\times(3>10^{10})^2$

$$E=1\times 9\times 10^{20}\text{ ergs}$$

In other words the Einstein formula shows us that one gram of matter is equivalent to 9×10^{20} ergs, or this is equal to $(9\times 10^{20})/10^7$ joules[1]

[1] Since one joule $=10^7$ ergs.

(C) $E=9\times10^{13}$ joules, or $E=9\times10^{13}\times.239$ calories[2]

(D) or $E=2.15\times10^{13}$ calories

To summarize, if one gram of matter all goes over to form energy we get 2.15×10^{13} calories of energy which is the equivalent in calories of the original 9×10^{20} ergs we had in step (A).

But in the beginning we had $P_4+5O_2\rightarrow P_4O_{10}+740{,}000$ calories.

The 740,000 calories is equivalent to

$$\frac{740{,}000}{2.15\times10^{13}}\text{ grams}=\frac{7.4\times10^5}{2.15\times10^{13}}=3.4\times10^{-8}\text{ grams}=0.000000034\text{ grams}$$

Thus we see that if the Einstein formula relationship holds, we will have the P_4O_{10} formed weighing less than the sum of the original 128 grams of phosphorus and 160 grams of oxygen by the amount of 0.000000034 gram.

Since in the laboratory the standard analytical balance weighs only to four decimal places, such a loss would not be detected. Ehret in explaining the law of conservation of mass states in his text book: "The mass of a system is not affected to a measurable extent by any ordinary chemical change within the system."[3]

Einstein would combine the laws of conservation of matter and conservation of energy into one law and would thus say that mass and energy are conserved together in any transformation involving them.

Summary

Actually in ordinary exothermic chemical changes there is a loss in weight. However, the loss is not observable if we weigh only to four decimal places. Only electrons in the outer valence shell are being transferred or shared. While in nuclear reactions, binding energy of the nucleus is evolved; here, we have a noticeable change in weight and as a result an immense amount of energy is released. Hence, Ehret's statement of the law of conservation of matter is one which takes into account the Einstein relationship.

[2] Since 1 joule = .239 calories.

[3] Ehret, *Smith's College Chemistry*, Sixth Edition, page 17, Appleton-Century Company.

EDUCATION IN THE FAR EAST

In his speech on behalf of the delegates, Dr. A. C. Joshi, Secretary, Department of Education, Punjab (India), said: "Those of us who have gathered here as delegates from various countries should have no hesitation in confessing that we represent largely an underdeveloped part of the world. We may further note that we are in our present state because we did not realize the importance of science early enough and are even today neglecting science.

NATURE RECREATION IN WILLIAM PENN'S COUNTRY*

William Gould Vinal
Grove Street, Norwell, Mass.

I. Penn's "Greene Country Towne" (1682)

William Penn wote a long farewell letter to his family before sailing on the good ship *Welcome* (1682). As to the children he said: "For their learning be liberal, spare no cost. Agriculture is especially in my eye. Let my children be husbandmen and housewives; it is industrious, healthy, honest and of good example." It was well for Penn to leave final instructions when entering on such hazardous undertakings. Out of the hundred passengers, smallpox took a toll of thirty, and yet it was called a "prosperous voyage." In another letter Penn wrote: "It were happy if we studied Nature more in natural things; and acted according to Nature, whose rules are few, plain and most reasonable."

At the confluence of the Schuylkill and the Delaware called Schackamaxon, "the meeting place of the sachems," William Penn met the Indians (1682). A barge with oarsmen brought Penn and his Council. All were unarmed. A peace compact that was kept for seventy years was made under a great elm. The tree was nearly 300 years old when overthrown.

Willian Penn, the naturalist, is not well known, yet his correspondence is teeming with notes about nature. "The trees of most note are the black walnut, cedar, cyprus . . . and oaks of diversesorts. Of all which, there is plenty for the use of man. . . . The fox grape (because of the relish it hath with unskillful palates) is in itself an extraordinary grape and by art, doubtless may be cultivated to an excellent wine, if not so sweet . . . they only want skillful vinerons to make good use of them. . . . Tis disreputable with me, whether it be best to fall in fining the fruits of the country, especially the grape, by the care and skill of art, or send for foreign stems and sets, already good and approved. . . . Of fowl of the land, there is the turkey, (forty and fifty pound weight) which is very great." Again he says that "The woods are adorned with lovely flowers for color, greatness, figure, and variety."

What a delightful medley of biblical words, old English, simple facts, advertising, and husbandry. Much is said "after the mode in London." A discerning shore naturalist can identify the cockles by the name of winkles and the conches as whelks. It is interesting that

* Written in June, 1937, when an itinerant naturalist for National Recreation Association, the beginning of Nature Recreation.

he considered mussels edible. People still have to be taught to eat them. He classified crabs as shellfish. The fact that he had no library or other natural philosopher to consult would indicate that Penn himself was no mean naturalist. William Penn located the site of Philadelphia (1682) "having a high and dry bank next to the water, with a shore ornamented with a fine view of pine trees growing upon it." He named the streets after trees. "His directions indicate a love of nature and an elegance of taste which are very remarkable." It was not until 1935 that William Penn's name was added to the Hall of Fame.

II. Germantown or Philadelphia Old Style (1683)

Germantown still has Quaker-like flavor. Quakers live in the hearts and homes of Philadelphians and have their yearly meeting. Many are descendants of 17th century stock. Strangers have to be "placed." The name Rittenhouse and Wistar (or Wister) abound in the telephone book. They have stone farm houses, colonial mansions and heirlooms. They care for horticulture, parks, boulevards, and the out-of-doors. There still are century old box bushes, cedars of Lebanon, towering cypress trees without "knees," magnificent copper beeches, fine dogwoods, immense chestnuts, historic oaks, notable poplars (really tulip trees) deserving Franklin's "King of the American Forests," swamp magnolias from the Jersey pine barrens, Virginia fringe trees, creeping yew, weeping beeches, and so one might go on through the list of tree aristocrats. Germantowners are not afraid to admit that they are interested in nature.

The German purchasers arrived in 1683. Francis Daniel Pastorius in a letter to his parents (1684) went on to say that "as relating to our newly laid out town Germanopolis or Germantown. . . . The main street is 60 feet wide and the cross streets 40 feet in width. Each family has a plot of ground for yard and garden 3 acres in size." Dr. Christopher Witt (1675–1765), the physician and naturalist, came to America in 1704. His 125 acre home was in Germantown where he started what some have called the first botanical garden in America (1718). In fact Germantown itself is one grand arboretum. Peter Kalm (1748) said that the houses were "built of stone which is mixed with glimmer." That is a much more poetic way then to say gneiss with mica, or serpentine building stone and marble steps. The William Bingham "Mansion House" (1790) where grew the first Lombardy poplars. Charles J. Wister had the first recorded ginkgo in America to fruit and one of the first ailanthus from China (about 1830). And then the keiffer pear produced by Peter Keiffer at his his nursery on Livesey's Lane. And the Morn's arboretum, now the property of the University of Pennsylvania. And there was James

Logan (1674–1751) who came to America in 1699 with William Penn. In 1735 he published experiments on maize. The early Germans sowed flax and made "fine linnens."

III. Philadelphia's Early Botanic Gardens (1731)

Botany began as a hobby with the herbalists who collected medicinal plants. In some cases, as with Bertram and Marshall, it became a passion which resulted in botanic gardens.

1. *John Bartram* (1699–1777), the Quaker farmer, purchased land on the Schuylkill three miles from the city. He built a house of stone with his own hands, hewing his own timbers and shaping his own rocks. On the south wall of the house appears "John and Ann Bartram 1731." On the east wall is carved "It is God alone, Almighty Lord, the Holy One, by me adored, John Bartram 1770." Over the door of his green house was "Slave to no sect, who takes no private road. But looks through Nature up to Nature's God."

John Bartram had little schooling and no neighbors with books. He was a plain, unlettered pioneer breaking land in the wilderness. His son William wrote of him—"While . . . plowing his fields . . . his inquisitive eye and mind were frequently exercised in the contemplation of vegetables, the beauty and harmony displayed in their mechanism." One day when resting he picked a daisy. He was inspired by its orderly structure. A passion was born which was to carry him to Carolina, Florida, and the Great Lakes. His wife felt that he was not opulent enough to give time to herbing but the idea haunted him. "What a shame, said my mind, that thee shouldst have employed thy mind so many years in tilling the earth and destroying so many flowers and plants without being acquainted with their structures and their uses." In a few days he hired a man to plow and went to Philadelphia. A bookseller gave him a Latin grammar. In three months he mastered it so that he could read Linnaeus. He thus became acquainted with all the plants on his farm.

Bartram was described as a person who "had a propensity to Botanicks from his infancy." James Logan in 1729 sent to England for a copy of "Parkinson's Herbal" to present to John Bartram. Bartram in a letter to Peter Collinson (17:4) said "I had always, since ten years old, a great inclination to plants, and knew all that I once observed by sight, though not their proper names, having no person nor books, to instruct me." Again he wrote: "Before Dr. Dillenius gave me a hint of it, I took no particular notice of mosses, but looked upon them as a cow looks at a pair of new barn doors," unconsciously pointing out that native interests may slumber if not awaked by the proper environment and leadership.

John Bartram traveled, collected, and corresponded with many

Europeans. In 1743 he crossed the Blue Mountains into the "impenetrable wilderness" to a treaty meeting. In 1753, with his son William, then 15 years old, he traveled to Cadwallader Colden's place west of Newburgh. In 1765, as botanist and naturalist for the king at a salary of 50 pounds a year, he and William went to Florida. He found the American bison in Florida and said "the peculiarity of the American buffalo is that instead of fur it is covered with fine, frizzled hair." It was during a trip to Georgia that he discovered a sapling along the Altahma River, near Atlanta which he brought back in his saddle bags. He named it the Franklinia tree in honor of Franklin. From this specimen sprung every known Franklinia in existence. There are a few specimens in the Bartram gardens today.

Bartram's Gardens were taken over by the Fairmount Park Commission in 1891 as a botanical shrine. For two years Thomas Meehan was head gardener. In 1923 the house was restored. The walks and many other improvements have been made possible by the John Bartram Association. One can vision friendly Indians or Peter Kalm, after whom the laurel (Pennsylvania's State Flower) was named Kalmia visiting in the garden or Franklin or Washington or Jefferson passing a quiet evening in front of the huge fireplace.

2. *William Bartram* (1739–1823) was the fifth son of John and as already mentioned a companion of his father in several journeys. His father wrote Collinson "I design to set Billy to draw our turtles, as he has time, which is only on Seventh Day afternoons and on First Day mornings, for he is constantly kept at school." He made drawings for Barton's "Elements of Botany" (1803) and wrote "Travels" (1791) which is an early work in American ornithology.

IV. Benjamin Franklin, "The Father of Applied Science"

Benjamin Franklin (1706–1790) had less than a year of schooling. "I was put to the grammar-school at eight years of age and remained there not quite one year" he states. At a school for writing and arithmetic "I failed in the arithmetic." His father's library was limited to theology. Franklin did not set a high value on the classics or on a college education. He observed that many graduates "lived as poor as Church Mice, being unable to dig, and ashamed to beg, and to live by their Wits it was impossible." To illustrate that "most of the learning in use is of no great use" he related an anecdote of an Indian treaty in 1744. The Commissioners let it be known that there was a fund at a college at Williamsburg for educating likely Indian lads of the Six Nations. The Indians had had experience and replied that several of their young people "were instructed in all your sciences; but when they came back to us they were bad runners, ignorant of every means of living in the woods, unable to bear cold or

hunger, knew neither how to build a cabin, take a deer, nor kill an enemy, spoke our language imperfectly, were therefore neither fit for hunters, warriors, nor counselors, they were totally good for nothing." The Indians invited the whites to send their children to the school of the woods for a real education. Franklin was a self-educated man.

Franklin's many-sided philosophy was expressed in "*Poor Richard's Almanac*" (1733–1758) which first appeared in December, 1732. It was published annually for twenty-five years and sold for two or three pence. The sayings were "gleanings" and "not a tenth part of all this Wisdom was my own." He goes on to say "I considered it as a proper vehicle for conveying instruction among the common people who brought scarcely any other books; I therefore filled all the little spaces between the remarkable days in the calendar with proverbial sentences, chiefly such as inculcated industry and frugality." A few of Poor Richard's proverbs follow:

> "The sleeping fox catches no poultry."
>
> "A rich rogue is like a fat hog,
> Who never does good till dead as a log."
>
> "Onions can make ev'n heirs
> and widows weep."

It was the textbook of the day and was based on moral natural history.

We have heard about Franklin the student, and Franklin the philosopher. *Franklin the scientist* is an equally striking story. He was about forty when he heard a lecture on electricity (1746). He was soon giving demonstrations in experimental electricity before the Junto Club.

These experiments led to the invention of the *lightening rod*. "As lightning is one of the means of punishing the sins of mankind, and of warning them from the commission of sins, it is impious to prevent its full execution." Again he said: "What signifies philosophy that does not apply to some use?" He chose to practice the latter in the lightening rod. *Franklin's kite* has become a classic story. His kite was made out of a silk handkerchief. An iron point was fastened to the upright stick and a key was fastened at the point where a silk string joined the lower end of the hemp line. Franklin completed his Philadelphia kite experiment in 1752.

Franklin also discovered that "the great northeast storms of this country begin to the leeward" which became the basis for *forecasting by the U. S. Weather Bureau*. He got the idea when an eclipse of the moon was obscured in Philadelphia by a northeast storm but was clearly observed for an hour in Boston, 400 miles away.

Franklin was a *science teacher* not under the formal set-up of a school room but of the world at large. Franklin was not only logical in his scientific investigation but also in presenting ideas as at the Junto Club. "Poor Richard's Almanac" is a model of instruction. Excerpts from a letter to a little girl to whom he had sent some books also have the earmarks of a teacher (1790). "They are written in familiar, easy manner . . . and afford a great deal of philosophic and practical knowledge, unembarras'd with dry mathematics . . . which is apt to discourage young beginners. I would advise you to read with a pen in your hand, and enter in a little book short hints of what you find that is curious, or that may be useful. . . . Have a good dictionary at hand."

V. Philadelphia's Early Museums (1784)

1. *Peale's Museum*

Charles Wilson Peale (1741–1827) was the son of a school master. He was fond of drawing and studied art in London under Benjamin West. He was the leading portrait painter in the Colonies including in his work such characters as Rittenhouse, Franklin, and General Washington (1779). Peale was asked to draw some mammoth bones (1784). This was just ten years after the first Continental Congress (Sept. 5, 1774). Through this experience he became interested in natural history. He decided to found a Philadelphia Museum and used successively a frame structure next to his house, a hall of the American Philosophical Society (1794), and Independence Hall (1802).

Peale used the principles of Linnaeus (Philosophia Bontanica Linnaei). There were "***Minerals*** that grow," "***Vegetables*** that grow and live" and "***Animals*** that grow, live, and move." When one notes that the collection included "a piece of human skin, tanned with bark, in the common way" he might doubt the sincerity of the museum but it must be remembered that at that time science itself was a curiosity and somewhat mysterious. If at first the ignorant were charmed by three legged chickens and other monsters, they may have been led to more useful pursuits. It was due to such attractions as a "Hairball, from the stomach of a Bullock" and lectures on electricity and chemistry, with the use of the magic lantern, that the museum had to be opened two evenings a week (1806), and at late as 1936 the public protested the storing away of an Egyptian Mummy to make room for habitat groups.

2. *The Academy of Natural Sciences of Philadelphia* (1812)

Dr. Amos Binney of Boston in a dedication note to his classical

work, "The Terrestrial Air-Breathing Mollusks of the United States," says: "To the Academy of Natural Sciences of Philadelphia to whose founders is due the first effective impulse given to the study of natural science of North America, and whose labors have been mainly instrumental in developing the natural history of this country." Philadelphia and Boston were the two centers of scientific study in Colonial times. A Bostonian whose scientific status is unquestionable labels Philadelphia the pioneer.

The early naturalists were humble men who were occupied during days and congregated evenings to discuss the creation. At first they met at the drug store of John Speakman and later at his home where they could talk uninterrupted. Speakman was a zealous "Friend" who sought to clarify his own mind. The organization took place in Mercer's Cake Shop, March 21, 1812, in the 37th year of the United States. Dr. Gerard Troost being present at this "meeting of gentlemen, friends of science and of rational disposure of leisure moments," was elected president (1812–1817). Thomas Say, although not present, was included as founder. Discussions on religious and political questions were excluded, a wise provision for the promulgation of natural philosophy. The organization was "an academy, a school of learners, rather than an association of learned men". The members have always been unselfish and devoted. Philadelphians have made generous contributions of time and money.

From a memorandum of the first meeting of the Academy it appears that "The operations of nature demand unprejudiced, attentive, and severe scrutiny; and that men may aid each other by a comparison of observations, their discussions must be free." The shadows of dogmas, religious and political, must have been around as Dr. Samuel Jackman of the University of Pennsylvania did not join because he had misgivings as to how the religious public would estimate such an undertaking. It was Dr. Jackman who suggested what he considered the compromising title of Academy of Science. Thus the members were to be "interested in the study of the works and laws of the Creator" rather than in the creation. Say slept in the Hall of the Academy under the skeleton of a horse and regarded eating as an inconvenient interruption to scientific pursuits. Most of the leading naturalists of America were to contribute to the *Proceedings* and *Journal*.

In 1860 the Jessup Fund was started "for the assistance of poor young men desiring to study natural history" and it was not until 1893 that "young women similarly inclined" were included. Charles Conrad Abbott was the first recipient. Angelo Heilprin, a Jessup Fund student, began his studies in 1879. He was made curator in

1883. Heilprin advocated popular courses of lectures and the opening of the museum on Sundays.

For 125 years the Academy centered its efforts on research. It was not until October 1936 that a Department of Education was established. Effingham B. Morris, President of the Academy (1928–1937) during its period of Rennaissance, in his introductory note to "Frontiers" (The Academy's new Magazine of Natural History) stated that the magazine is "addressed to all persons, old or young, who wish to increase their knowledge of the world of nature."

3. *The Wagner Free Institute* (1885)

Willian Wagner (1792–1885) was a "son of the Wissahickon" along the banks of which he spent his childhood and obtained his first love of nature. It was in the Wissahickon Valley that he began his collection of nature curios. It is said that his mother had to put bucksin pockets in his trousers to take care of the rough contents. When only twenty he was supercargo for Stephen Girard and went on a two year voyage. As agent for Girard he visited many countries. He employed his leisure time in visiting scientific institutions. He sailed on Clipper ships under sealed orders, such as—buy gin in London, sell it in the Brazils, bring coffee from Rio Janeiro to Liverpool.

Wagner was inspired by Girard's erecting Girard College for orphan boys and on the campus of which no clergyman should set foot. Wagner was the Peter Cooper of Philadelphia. He founded a free institute for collegiate training where lectures and seven courses in science (fourteen weeks each) could be obtained. It takes four years to complete one branch of science and credit is allowed by Temple University. The institute not only offers courses but also the advantages of a public library and a museum. The corner stone was laid on the day that Fort Sumter was fired upon in 1861, and the building was dedicated in 1865. By 1908 there were thirteen lectures for children. For four seasons commencing June 18, 1928 the institute sponsored a self-directed nature trail for the *Evening Bulletin*. It appeared every Monday for fourteen weeks. It featured local history and trees and included a small map and outline drawings of typical leaves. The first hike was to Lemon Hill in Fairmount Park. The Wagner Institute is a unique organization.

VI. Philadelphia and Descriptive Natural History (1753–1849)

During this age—which extended over a period of about a hundred years—the Philadelphia naturalists were busy naming and pigeonholing species. A list of Philadelphians of the period contains the out-

standing naturalists of the country although it is by no means complete. Each of the following made a contribution to popular natural history or nature study.

1. *Audubon, John James* (1785–1861) resided on a 285 acre farm on the banks of the Schyulkill, north of Norristown.

2. *Barton, Dr. Benjamin Smith* (1776–1815) was Professor of Natural History and Botany in the College of Philadelphia which later became a part of the University of Pennsylvania. He wrote the first elementary work on botany, the *Elements of Botany: or Outlines of the Natural History of Vegetables* (1803).

3. *Jefferson, Thomas* (1743–1826). Although "politics" was Jefferson's duty and science his passion, he is better known because of his presidency. In stating his political principles he said "and I am for encouraging the progress of science in all its branches and not for raising a hue and cry against the sacred name of Philosophy" (about 1801). Jefferson was interested in the extinct animals of North America and financed attempts to collect fossil mammals. One of the rooms of the White House was set aside for the study of the bones of the Mastodons and ground sloths. Jefferson's work as a scientist was far ahead of his day. He rejected the Mosaic account of the creation and the flood as fiction. He kept a record of the weather for nearly half a century. At Monticello he had a microscope and a telescope. He could reckon latitude and longitude and calculated the eclipse of 1778. He encouraged exploration of Indian mounds and tried to introduce olive culture into the United States. He received a gold medal from France for designing a plow. That he was elected the third president of the American Philosophical Society is a testimony that his fellow scientists held him to be a scientist of worth.

4. *Nuttall, Thomas* (1786–1859) was born in England. He came to America at the age of twenty-two and held Phildadelphia as his base. There is a story, which some believe fabulous, that he was ignorant of botany and took the common greenbrier, thinking it the passion flower, to Doctor Barton, Professor of Botany at the University of Pennsylvania. Doctor Barton gave the boy a lesson in botany which is said to have made Nuttall a botanist. He set his own type for what was probably his most important work, *The Genera of North American Plants*. He was Curator of the Harvard Botanic Garden and Lecturer in Natural History (1822–1833). While at Cambridge he produced his *Manual of the Ornithology of the United States and Canada, Land Birds* (1832) and *Water Birds* (1833).

5. *Rafinesque, Constantine Samuel* (1783–1840). According to Rafinesque's own account "The first premium I received in a schoolroom was a book on animals, and I became a zoologist and natural-

ist." He was born in Constantinople. Rafinesque was a vagabond naturalist, in the eyes of the museum naturalists, perhaps too often lured from the desk.

6. *Say, Thomas* (1787–1834). Thomas Say, the naturalist, had gifted antecedents, both liberal in policies and science-minded. His grandfather, Thomas Say (1709–1796), was a French Huguenot Friend. He promoted schools for white and blacks, helped care for the French refugees fron Nova Scotia (1757), and gave free medical advice to the poor. Say showed no affiliation for his teachers or for the three R's. He helped his father with his herbs, collected bugs and butterflies, and received encouragement from his great uncle, Willian Bartram. Among the first officers of the Academy of Natural Sciences he was elected "Conservator."

Madame Fretageot wrote Maclure (1829) that "Say is not in good health, he attends to the garden that is work(ed) by our little boys." In another letter she writes that "Say would rather run ten miles after boys than write a letter." In 1831 she says "We have stopped the Disseminator and the children are to issue a half sheet twice every month at fifty cents per annum. Say will help them and the little paper will keep the name of the school."

From the book of Maximilian, Prince of Wied (1843), who visited New Harmony (1832–33) it appears that "Mr. Say's house was in a garden, where he cultivated many interesting plants of the interior of Western America. I saw there a large Maclura Aurantiaca (Nuttall), the bow or yellow wood, or Osage orange, from the river Arkansas, of the wood of which many tribes make their bows."

On the north face of Say's monument, a shrine for naturalists in New Harmony, appears the following:

"Votary of Nature even from a child,
He sought her presence in the trackless wild;
To him the shell, the insect, and the flower
Were bright and cherished emblems of her power.
In her he saw a spirit all divine,
And worshipped like a pilgrim at her shrine."

7. *Wilson, Alexander* (1766–1813) arrived without purse or purpose at the mouth of the Delaware from Scotland in 1794. His mother intended that he study for the ministry but he became a country school master and took up bird study as a recreation from school. He finally settled at Kingsessing on the Schuylkill (1802) near Wm. Bartram's graden. Wilson was of a poetic nature and wrote

"Sweet flows the Schuylkill's winding tide,
  By Bartram's green emblossomed bowers,
Where nature sports in all her pride,
  Of choicest plants and fruits and flowers."

VII. Joseph Leidy, Greatest American Naturalist (1853)

Joseph Leidy (1823–1891) came from a *well-endowed lineage* of French-German ancestry. His great-grandfather arrived in Philadelphia in 1729 and purchased 400 acres from the Penns. He was *born in a favorable environment* to become a naturalist.

"I first collected curiously colored leaves and pasted them in a book. I was then induced to look for what names had been given. Thus I was introduced to the study." He raised silkworms when nine and removed the sick ones. Sometimes he "cut school" to be in the fields. As early as ten he had the notebook habit and made accurate drawings and notes, some of which are on display at the Academy. As a boy Leidy showed no ability in the classics and his schoolmates thought him queer.

"When I was a boy I used to pick up rocks merely because I thought they were pretty. One day a man named Holbrook came to the school I attended and delivered what I then considered a most impressive lecture. He had a number of specimens of quartz, gneiss and granite. He spoke of the properties of those minerals and explained how they went to form granite, etc. After school we went searching for minerals." With the right mixture of air and gas a spark will drive an automobile. When a boy has capacity and interest only a slight occasion in needed to get action. It was always so in the life of Joseph Leidy. One time a cousin burst out laughing and said "Well: they will be amused at home when they hear what cousin Joe was doing; sitting on the floor with an earthworm stretched on a board looking at its insides."

Leidy was one of the last men of science to master the complete field. He was not only a minerologist, anatomist, parasitologist, paleontologist, and evolutionist but *a teacher*. Edward Morse said that "It was the personal contact of a great master with students of every branch of natural history in which Leidy's influence on the science of his time exerted its greatest effect." One time Leidy handed a medical student a bone. The student did not recognize it. An hour later he asked the student to recite something in Latin which the student did very glibly. Receiving this information Leidy said "It seems to me you know the books of Vergil better than you do the book of nature. Study the latter even more accurately than you have the former." Student welfare was next to his heart.

Being a great teacher he deprecated "burdensome names." His *Elementary Treatise on Human Anatomy* has 495 illustrations, nearly half being original. He took scrutinizing care to make the text intelligible and clear. In the classroom he had no lantern slides. Being an artist he made blackboard drawings to illustrate his lectures.

Leidy believed that "The Natural Sciences should be cultivated

in our common schools. Most of us have at some time wished we could visit the moon, but even if we were indulged how few could on coming back to earth give an intelligent account of what we saw there." He also felt that popular books on natural science were *much needed*. He did not care to write them himself.

Leidy had a *poetical mind*. When he observed the "basket worms" he wrote that from the pupa case "is produced the moth, the male of which awaits the night to leave his habitation in search of a mate. The female never leaves her silken dwelling, nor does she even throw aside her pupa garment: it is her nuptial dress and her shroud." "You urge that classical studies enlarges the imagination" he said to Nolan. "There's the trouble! Men's imaginations are sometimes enlarged and stretched to an inordinate extent until at last they cannot use their common sense at all. Nature is sufficiently lovely already without being dressed thus in tinsel. I seldom read any of our poets without being disgusted by their false imagery, all the result of overgrown imaginations. If they knew more of natural history, if they were better acquainted with things as they are they would be more accurate and therefore more enjoyable." He admired Holmes' "Chambered Nautilus" and Whittier's "The Prayer of Agassiz."

Joseph Leidy served the Academy for 46 years. For this period it was his science-home and the University his place of teaching. The first was his recreation and the second his livelihood. Leidy once visited Huxley who was not at home. He received this letter: "Dear Dr. Leidy: Once Mrs. Huxley saw an iceberg on which rode a polar bear, a sight I have never witnessed. Now that she has seen Leidy and I have not, there will be no living with the woman."

VIII. The Pine Barrens and Conservation

A Sunday in May in the New Jersey Pine Barrens is one of those never-to-be-forgotten experiences. When given the choice of visiting the coastal plain or the mountains with congenial friends the author chose to be a "Piney." Omitting any homesickness for Cape Cod, after two years of travel, I wanted to tramp the land of Rafinesque, Pursh, Nuttall, Peter Kalm, Bartram, and Audubon. I too wanted to worship at the shrine where America's Pilgrim naturalists had trod.

It was over fifty years before that the Botanists meeting with the American Association for the Advancement of Science made a special pilgrimage to this plant haven. "In spite of the fact that the thermometer had passed above the nineties, the whole party of fifty, including ladies and Britishers, wandered out for a mile or so amid a vegetation remarkably rich in showy and interesting flowers and botanical rarities . . . the cry ran all along the line that the Schizaea was found. There was a succession of disappearing forms down the

railroad embankment into the thicket, where all, great and small, went down on hands and knees to gather the precious little ferns of such unfern-like aspect." Dr. Asa Gray in reminiscing believed that he had first visited the pine barrens in 1832.

As soon as the wind wafted to us the resinous odor of the Pitch pine (Pinus rigida) we knew that we had arrived. There they stood—dwarfed—with bare flaky trunks. There were the familiar scrub oaks (Quercus ilicifolia) standing out in the most barren stretches. As though to remind a Cape Codder that he was a few hundred miles farther south there were a few oddities such as the black-jack oak (Quercus marilandica) with its glossy green leaves and bright rusty under-surfaces lifted now and then to view by the breeze. The stagger-bush (Pieris mariana) had the largest huckleberry blossoms I ever saw attracted my eye at once. And there was the turkey-beard (Xerophyllum asphodeloides). Linnaeus obtained his original specimen from "Barthram." The Virginia chain fern (Woodwardia virginica)—that too does not venture to Cape Cod but there were plenty of old Cape Cod standbys. When we drove down a typical sand road to "Rattlesnake Ace's" to leave a pine snake we had caught we saw the prickly pear (Opuntia opuntia) in his garden. I had always thought that the opuntia cactus had been introduced on the Cape but Mr. Sim thought it had always grown in the pine barrens. The large mats of bearberry (Arctoslaphylos uva-ursi) and crowberry (Corema conratlii) on the white sand barrens brought to mind that corema was named after Solomon W. Conrad (1779–1831), a Professor of Botany at the University of Pennsylvania (1829–1831). This must have been a "stamping-ground" for Professor Conrad too. The "Pineys" called the bearberry "University"—a quaint proof they had heard some botanist of yore—perhaps Bartram a century ago—say "There's uva-ursi." We were soon literally befuddled in a network of "Cape roads"—that was familiar too—but it was a real pleasure to be lost in a lonely restful heath. There was sweet scented goldenrod (Solidago odora). There were cranberries, huckleberries, winter green and trailing arbutus (we would rather say Mayflower) in heatherlike profusion. Mr. Sim told me that the heath hen—the same one, "the last of the race," just died on Martha's Vineyard—was exterminated here back in the seventies. The heath fragrance and piney air was a nerve quieter. It must have been in a place like this that Henry Vandyke wrote "Between the Lupine and the Laurel."

One cannot wander through the pitch pines very long before the spicy sweet-pepper-bush (Clethra alnifolia) or the swamp azalea (Azalea viscosa) lures him to a white cedar swamp. He will surely be attracted to the southern magnolia (Magnolia virginiana) with its perfumed creamy flowers and shiny leaves. Philadelphians are en-

couraging vandalism and the destruction of the shrub when they purchase these flowers on the sidewalks. The swamp magnolia must not go the way of the heath hen or passage pigeon.

Exploring a cedar swamp soon takes one into a bog and *that is an experience*. Nuttall knew the "sphagnous swamps" of the "Pine Barrens." Those who are authority say that the marsh rat and Stone's lemming live in the sphagnum bogs Be that as it may we saw the three fly traps of Cape Cod (Drosera longifolia, D. rotundifolia, and D. filiformis). And then there were pitcher plants (Sarracenia purpurea), pogonia, and pipewort (Eriscaulon decangulare). Bog-trotting is the crowning event of a day in the Pine Barrens.

This brief description suggests, even to the amateur, that the New Jersey Pine Barrens is a unique territory. Not all the pitch pines have been cut for charcoal. Not all the bogs have been filled to grow cranberries. Not all the cedars have been cut for posts. Not all the heather has been scarred by forest fires. Another quarter of a century of the present inroads and one of Philadelphia's most interesting natural history areas will have been exterminated forever. The coming generations will never see the living passenger pigeon or the heath hen. Their bones can rest beside those of the giant sloth, the giant beaver, and the saber-toothed tiger. Perhaps future inhabitants of the Penn country will never cross the heather or go bog-trotting. They have no voice in the matter. It is we who are the custodians of the Pine Barrens.

"By the 20th of May the beautiful laurel began blooming in the South Jersey Pine Barrens. On Memorial Day it was beginning to bloom along Lincoln Drive in Fairmount Park. This week will see its start at Valley Forge . . . and toward the end of next week 'Laurel Time in the Poconos' will attract thousands of people to that region." First one must note that every one of these areas, except the "Pine Barrens" is set aside for all the people for all time. Secondly, it must be evident that the problem is not a matter of state boundaries. Nature happened to shape the New Jersey coastal plain with sediment brought from Pennsylvania's Piedmont region.

IX. The Wissahickon and Nature Lore

"Be sure and see the Wissahickon" was the first advice I received on arriving in Philadelphia. I gathered that it was the best bit of nature that Philadelphia has to offer. The Wissahickon portrays the scenery of the Schuylkill River when it was densely wooded and the haunt of the Indians. The Delawares had to accustom themselves to solitude—a lost art. They had to catch fish and wild game at the expense of hardship and danger. Patience, then as now, was not inherited but learned by practice. They knew by evidence whether

there were fish in the stream. They knew the signs of squirrel, grouse and deer. Their existence depended on observation. Observation is a lost art. If Philadelphia youth is to get nature obervation it must be in the Wissahickon.

The Wissahickon is really a non-glaciated Appalachian gorge 6.5 miles long. It represents 1200 acres of the 3845 acre Fairmount Park System which begins almost at the doorstep of City Hall. It has a parkway, bridle trails, and hiking paths paralleling the creek. The valley is arched with bridges. The cliffs are well wooded.

Wissahickon is the Delaware for "Catfish Creek." There was a time when "Catfish and Waffles" was the bill of fare peculiar to the roadhouses of the Wissahickon Valley. It was a prize dish which ranked with quail on toast in Boston. In Boston catfish are called *hornpout and hornpout is "foreigner's food."*

There was a time when a boy could fish any day, but now fishing in Wissahickon brook is limited to Wednesday and Saturday during trout season (April 15–July 31). When one can go trout fishing within the limits of a big city he has something to brag about. But Philadelphians do not always know when to brag. There are those who still take pride in their streets paved with rounded stones. When the schools closed for a week day in May I saw 25 boys fishing in front of the Art Museum, where the sewer empties into the Schuylkill. It kept one park guard busy to prevent the boys cutting high priced shrubbery for fish poles. Boys have a right to fish. Boys have a right to fish poles. A park guard to work with them instead of against them would be providing a training in citizenship rather than making criminals. Why not stock the Wissahickon with suckers, catfish, sunfish, and eels? Teach the boys how to fish. Better yet—teach them the life history of the catfish, etc. and the reasonableness of a closed season. Rear conservationists instead of poachers.

There was a time when a fellow not only could catch fish but he could build a fire and cook them. Today it is illegal to make a fire in Fairmount Park. People from other cities where hundreds of outdoor cooking stoves are provided would be astonished to find no such provision in what is the largest park in the world within city bounds.

There have been other changes in the Wissahickon. They have been so gradual that generations of people may live in Philadelphia and be unmindful of the changes. The last of the Wissahickon Paper Mills (removed in 1884) is now the Park Guard House. No one rides to the mill to get corn, wheat and linseed ground. No one hunts coons or shoots turkeys. The pigsty, the corncrib and the woodshed have long since been exterminated in Fairmount Park. A few old springs sort of compensate. Crowds hang around these springs. Going to the spring with a jug may be reminiscent of the old spring house and

home days. Perhaps Peter Kalm and John Bartram drank at these springs. To older folks it may bring back memories of dairying. Perhaps the children are unconscious of an inner urge for the wild beyond that of a thirst and a cool drink. And the sports of Fairmount have changed. Where are the children playing run-sheep-run and hare and hound?

Ranger naturalists are needed to teach the people the lore of the Wissahickon. I can picture bird trips, mineral collectors, fishers and exploring. I can see an evening camp fire and a ranger spinning yarns about Johann Kelpius (1673–1708), the "hermit of the Wissahickon," who arrived in Philadelphia in 1694. He came to Penn's Wilderness with German Pietists to seek freedom for religious convictions. They celebrated their landing on St. John's eve by building a huge fire on the Fairmount Plateau and then scattered the brands to symbolize the summer solstice and the waning of the sun's power. The Pietists expected a millennium in about 1700. They practiced magic, divining, alchemy, and cast horoscopes. Kelpius also had a botanical garden. Whittier described him thus:

> "Painful Kelpius from his hermit den
> By Wissahickon, maddest of good men.
> Deep in the woods, where the small river slid
> Snakelike in shade, the Helmstadt Mystic hid,
> Weird as a wizard, over Arts forbid."

An orginal painting of Kelpius was made by Dr. Christopher Witt of Germantown and is celebrated as the first oil painting made in America (1705).

We have seen that Penn was a true naturalist. He once wrote that "The country is to be preferred. It is both the philosopher's garden and his library in which he reads and contemplates the power, wisdom, and goodness of God." He may have been talking about the Wissahickon. Gabriel Thomas in *An Historical and Geographical Account of the Province and County of Pennsylvania and of West Jersey* was not trying to be humorous when he spoke of the bull frog which "makes a roaring noise hardly to be distinguished from the well known beast from whom it takes its name" and "that wonder of stones the salamander-stone, found near Brandywine River, having cotton veins within it which will not consume in the fire though held there a long time." That was his way of describing asbestos.

Edgar Allen Poe in his "Morning on the Wissahiccon" (1844) intimates that the traveler who would behold the finest landscapes "must walk, he must leap ravines, he must risk his neck among precipices, or he must leave unseen the truest, the richest, and most unspeakable glories of the land." He concluded that "now the Wissa-

hickon is of so remarkable a loveliness that were it flowing in England it would be the theme of every bard."

John Greenleaf Whittier, the Quaker poet, lingered long enough to write the "Pennsylvania Pilgrim" (1872). He described the coming home of cows when the Wissahickon was back country.

> "The oxen from their ploughs
> Rested at last, and from their long day's browse
> Came the dun files of Krisheims home-bound cows."

Only lilacs and mazzard cherries mark the old home sites. The bare foot boy and the dairy maid belong to days of yore. Penn, Thomas, Poe, and Whittier saw the Wissahickon with different eyes.

Tom Daly, the Philadelphia poet, stored pleasant memories of the Wissahickon to write

> "There earliest stirred the feet of spring,
> There summer dreamed on drowsy wing,
> And autumn's glories longest cling
> Along the Wissahickon."

The sentiment of the Wissahickon is best summed up by Cornelius Weygandt, Professor of English Literature at the University of Pennsylvania.

"They are not very different, these Wissahickon Hills . . . they are . . . all that hills should be. They bring to the boy the little adventures he must have to thrive. . . . They give the man the peace he needs to restore him to zest in living. And then they are the hills I know best, my hills, the hills of home. . . . During the cubbish years I hunted the hills for small pelf and treasure, it was not often I thought of this teaching of their beauty."

Each age requires a new vision. In 1812 it required progressiveness for the city to obtain five acres of ground for olde park "Faire Mount." What is needed now is nature trails, trailside museums, and youth hostels. Philadelphia has tradition, culture, and vision. Philadelphia, the birth place of the Declaration of Independence and of the Constitution of the United States, the home of the first Academy of Natural Sciences, and the focus of scientific interest in Colonial times, will surely not lag in its program for nature recreation.

COLLEGE TEACHER AWARDS

The Manufacturing Chemists' Association announced that this coming June it will present six medals and awards for outstanding teaching of chemistry at the undergraduate level in American colleges and universities.

These awards are being made in recognition of the vital importance of work done by college teachers in the training and inspiring of the future scientists and other technical graduates essential to the nation's progress. Cash awards of $1,000 each as well as medals and citations, will be granted to the winners.

THE READING DIFFICULTY OF SOME RECENT TEXTBOOKS FOR SCIENCE

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Introduction

During the past few years there has been a great deal of concern in educational circles about the problem of reading. This concern has led to a number of research studies dealing with the reading difficulty of textbooks in various subject-matter areas. Among the most extensive series of such studies is one dealing with textbooks of science.[1,2,3,4,5,6,7,8,9,10]

In general, this series points out four basic facts:

1. The levels of reading difficulty of many textbooks in science are too advanced for students for whom they are written.

2. The differences between the levels of reading difficulty of the easiest and most difficult textbooks in all areas of science are significant.

3. In some textbooks of science whose *average* level of reading difficulty seems satisfactory, there are passages that would be difficult even for some college students.

4. Many textbooks of science contain non-technical words that could be replaced with easier synonyms.

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[1] Vogel, Louis F., "A Spot-Check Evaluation Scale for High School Science Textbooks." *The Science Teacher*, XVIII (March 1951), 70–72.

[2] Mallinson, George Greisen, "Some Problems of Vocabulary and Reading Difficulty in Teaching Junior High School Science." School Science and Mathematics, LII (April 1952), 269–74.

[3] Mallinson, George Greisen, "The Readability of High School Science Texts." *The Science Teacher*, XVIII (November 1951), 253–6.

[4] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks in Junior High School Science." *School Review*, L (December 1950), 536–40.

[5] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks for General Physical Science and Earth Science." School Science and Mathematics, LIV (November 1954), 612–6.

[6] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks for General Science." *School Review*, LII (February 1952), 94–8.

[7] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks for High-School Biology," *The American Biology Teacher*, XII (November 1950), 151–56.

[8] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks for High-School Chemistry." *Journal of Chemical Education*, XXIX (December 1952), 629–31.

[9] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks for High-School Physics." *Science Education*, XXXVI (February 1952), 19–23.

[10] Mallinson, George Greisen, Sturm, Harold E., and Patton, Robert E., "The Reading Difficulty of Textbooks in Elementary Science." *Elementary School Journal*, L (April 1950), 460–63.

Since these studies have been published the investigators have received a number of letters from book companies and authors concerning the implications of the findings. The authors naturally began to wonder whether some action was being taken to remedy some of the weaknesses revealed by the studies.

Hence they decided to analyze some of the newer textbooks using the same techniques of the previous studies in order to determine whether the reading difficulties had been reduced.

Methods Employed

All textbooks that appeared during the years 1953 and 1954 which

Table I

Levels of Reading Difficulty of Recent Textbooks for Science

Field and Publisher	Reading-Difficulty Score of Sample							Average Reading Difficulty Score	Grade Level of Difficulty
	1	2	3	4	5	6	7		
Elementary Science									
Grade 4—Pub. A	1.97	1.37	1.50	2.63	1.11	—	—	1.716	V completed
Grade 5—Pub. A	1.50	2.36	2.22	1.81	2.30	—	—	2.038	VI completed
Grade 6—Pub. A	2.37	1.96	3.90	2.83	4.04	—	—	3.620	VII completed
Grade 7—Pub. A	3.70	1.95	3.96	2.96	3.97	—	—	3.308	VII completed
Grade 8—Pub. A	3.35	5.97	2.50	5.29	4.13	—	—	4.248	XI completed
General Science									
Grade 7—Pub. B	3.74	2.30	4.23	5.37	1.96	—	—	3.520	VIII completed
Grade 7—Pub. C	3.75	4.30	2.98	5.83	4.51	4.51	—	4.313	IX completed
Grade 9—Pub. A	4.09	4.91	5.64	5.84	3.57	6.17	4.71	4.990	X completed
Grade 9—Pub. D*	4.84	5.84	5.15	6.24	3.85	4.23	2.76	4.792	X completed
	5.43								
Grade 9—Pub. E	3.76	3.98	4.37	3.54	4.03	3.96	—	3.940	VIII completed
Grade 9—Pub. F*	1.63	1.89	1.92	2.82	3.34	—	—		
	1.68	2.66	1.43	2.61	1.76			2.11	VI completed
Biology									
Publisher A	3.77	4.29	4.02	3.90	4.56	3.49	3.29	3.902	VIII completed
Publisher C	5.03	3.62	8.35	4.63	4.77	7.04	—	5.573	XIII completed
Publisher F	3.71	6.63	4.37	7.11	4.51	5.77	—	5.350	XII completed
Publisher G	3.84	6.44	3.08	4.57	4.15	6.96	—	4.840	X completed
Publisher H	4.11	.96	4.09	2.83	3.23	—	—	3.044	VII completed
Chemistry									
Publisher I	2.71	4.70	8.57	5.97	6.29	8.31	4.50	5.864	XIV completed
Physics									
Publisher F	4.64	4.97	3.36	4.17	4.90	6.43	5.17	4.805	X completed
Publisher H*	6.24	5.01	4.43	5.73	6.64	4.97	5.89		
	7.84							5.843	XIV completed
Publisher J	5.81	5.08	5.98	5.49	7.58	—	—	5.988	XIV completed
Publisher K	4.03	3.83	4.69	2.64	4.04	2.29	5.91	3.832	VIII completed
Publisher K†	5.81	5.61	5.73	6.08	4.96	5.56	—	5.625	XIII completed

* Eight samples were taken from the textbook of Publisher D, 10 from that of Publisher F, and 8 from Publisher H.

† Publisher K produced two textbooks for physics.

had not been reviewed previously were analyzed using the Flesch[11] formula in the same way as it had been used in the previous studies. The grade-levels of difficulty of the textbooks were similarly determined. Table I summarizes the findings.

Conclusions

In so far as the techniques used in this study may be valid, the following conclusions seen defensible:

1. There is a great deal of variation among the levels of reading difficulty of textbooks designed for the same field of science. For example, in the field of physics the easiest of the recent textbooks (Publisher K), has a grade level of difficulty of grade VIII completed while the most difficult (Publisher H and J), are suitable for grade XIV, or college sophomores. Similar variations may be found with the textbooks for other science fields. Hence, reading difficulty seems to be a characteristic that needs to be evaluated when textbooks are selected.

2. Recent textbooks do not seem to be easy. If the level of reading difficulty of a textbook should be one grade level below that of the students for whom it is designed, few can be considered suitable. An examination of the data in Table I shows that many have grade levels of reading difficulty higher than the grade levels of the students for whom they are designed.

3. Average grade levels of difficulty can be quite misleading. For example, one sample from the textbook for physics of Publisher F had a grade level of difficulty of grade VI (2.29) while another sample had a grade level of difficulty of grade IV or college sophomore (5.91). In many cases, therefore, a satisfactory average may conceal many difficult sections.

4. It would seem that recent textbooks in science are as variable, and are likely to cause as much difficulty, as their predecessors which were analyzed in the earlier studies. One might suggest that publishers need to warn authors to pay greater attention to this particular characteristic. It is obvious that, no matter how well organized, a book is not likely to be of much value to students if they cannot read it with sufficient ease to understand it.

[11] Flesch, Rudolf, *The Art of Plain Talk*. New York: Harper and Bros., 1946. p. 205.

Everyone talks about the weather yet no one does anything about it.

—Charles Dudley Warner in 1890

We stand today on a bright oasis of knowledge in an illimitable desert of the unknown.

—Lord Salisbury

A THEOREM OF RELATED TRIANGLES, THE CENTERS OF GRAVITY OF A FULL AND A SKELETON TRIANGLE

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(1) A triangle ABC, Fig. 1, has its sides BC, CA, AB bisected at D, E, F, respectively. The triangle DEF will be called the ***quarter*** triangle of the triangle ABC. Through ABC are drawn lines QR, RP, PQ parallel to BC, CA, AB to form a triangle PQR. This triangle PQR will be called the ***quadruple*** triangle of the triangle ABC.

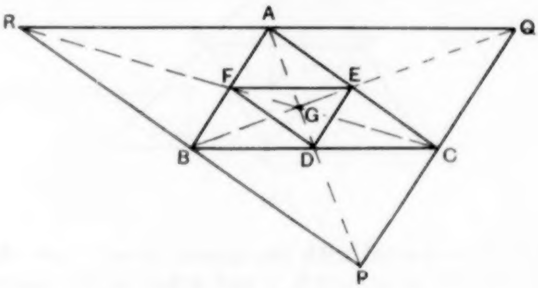

FIG. 1

For distinction from what will be considered later we may call triangles *full* triangles when we consider the areas or masses or weights of the matter enclosed within the boundary.

It is evident that the full triangles ABC, DEF, PQR have corresponding linear dimensions in the ratio $1:\frac{1}{2}:2$ and corresponding areal dimensions or weights in the ratio $1:1\frac{1}{4}:4$. Also Geometry and Mechanics show that they have a common center of gravity G at the intersection of the common medians.

(2) The problem on which I started was to find the center of gravity (hereafter called CG for short) of a ***skeleton*** triangle ABC (Fig. 2), i.e. a triangle composed of three uniform thin rods BC, CA, AB. The well-known Theorem of Moments tells us that for this purpose each rod may be replaced by its mass placed at the mid-point of the rod. Let the rods have lengths a, b, c, then the problem is that of finding the center of gravity of three concentrated masses a, b, c placed at D, E, F, the mid-points of the sides BC, CA, AB respectively.

To do this first consider a and b. Their common CG must lie on DE. Let its position be H (Fig. 2). The Theorem of Moments says the product $a\times DH=b\times EH$. The masses a and b may now be re-

placed by a mass $(a+b)$ at H. The CG of mass $(a+b)$ at H and mass c at F must lie on FH and divide it at K such that $(a+b)HK=c\cdot FK$. To find the position of K we have

$$\frac{DH}{EH}=\frac{b}{a}=\frac{b/2}{a/2}=\frac{DF}{EF}$$

and this by a well-known theorem on the triangle proves that FH bisects the angle EFD.

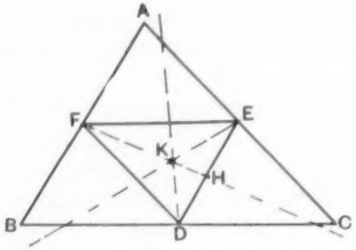

FIG. 2

If we had first started with the masses b and c we should have found that the CG of masses b, c and a lies on the bisector of the angle EDF and if we had started with the masses c and a we should have found the CG of c, a and b lies on the bisector of the angle DEF. We know that the three bisectors of the angles of a triangle have a common intersection, this point being the Incenter of the triangle. Therefore K is the *Incenter of the triangle DEF*.

Thus *the CG of a skeleton triangle ABC is at the Incenter of the quarter triangle DEF.*

Note: DK, EK, FK do not pass through $A\cdot B\cdot C$ respectively; $DCEF$ is a parallelogram but H is not the mid-point of DE.

The lines through K from the vertices A, B, C to the opposite sides of the triangle may be called the *gedians* (g for gravity) of the skeleton triangle ABC. In this way we distinguish between the *medians* and the *gedians*.

(3) *The relation between the Incenter K of the triangle DEF and the Centroid G and Incenter I of the full triangle ABC.* I now prove that IGK lie on a straight line and $IG=2GK$. It is possible to do this by Euclidean Geometry (see later) but I first obtained the result by Analytical Geometry so I follow this approach first with necessary digressions on the positions of the Centroid of a full triangle and of the Incenter of a triangle.

(4) *Analytical method of finding the position of the Centroid of a full triangle ABC:* Let the coordinates of ABC (Fig. 3) be x_1y_1, x_2y_2, x_3y_3

respectively. We know that the CG lies on the median AD and divides it such that $DG=\frac{1}{3}DA$.

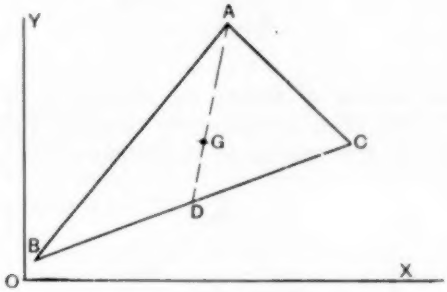

FIG. 3

The coordinates of D are

$$\frac{x_2+x_3}{2}, \qquad \frac{y_2+y_3}{2}.$$

Also

$$\frac{x_D-x_G}{x_D-x_A}=\frac{1}{3}.$$

Therefore

$$3x_D-3x_G=x_D-x_A$$

whence

$$3xG=2x_D+x_A=x_2+x_3+x_1$$

or

$$\left.\begin{aligned} x_G&=\tfrac{1}{3}(x_1+x_2+x_3) \\ \text{Similarly}\qquad y_G&=\tfrac{1}{3}(y_1+y_2+y_3) \end{aligned}\right\}. \tag{1}$$

An alternative method starts with the assumptions (proved in the higher textbooks) that for mechanical theorems on moments we may suppose the mass M of the full triangle may be replaced by three equal masses $M/3$ placed at the mid-points of the sides. The sum of the moments of these masses about OX or OY must be equal to the moment of the whole mass collected at the CG about OX or OY.

Therefore if $\bar{x}\bar{y}$ are the coordinates of the CG

$$M\bar{x}=\frac{M}{3}\left\{\frac{1}{2}(x_2+x_3)+\frac{1}{2}(x_3+x_1)+\frac{1}{2}(x_1+x_2)\right\}$$

or

$$\bar{x}=\frac{1}{3}(x_1+x_2+x_3)\cdot$$

Similarly for $\bar{y}$.

(5) *Analytical method of finding the position of the Incenter of a triangle ABC:* ABC (Fig. 4) shows the triangle with the angle bisectors $A\alpha$, $B\beta$, $C\gamma$ intersecting at the incenter I. Let x_α, y_α be the

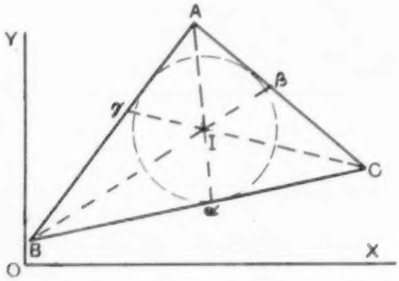

FIG. 4

coordinates of α. Since $A\alpha$ bisects $\angle BAC$,

$$\frac{B\alpha}{C\alpha}=\frac{BA}{CA}=\frac{c}{b}\quad\therefore\quad\frac{C\alpha}{a}=\frac{b}{b+c}\cdot$$

Also

$$\frac{x_\alpha-x_2}{x_3-x_\alpha}=\frac{B\alpha}{C\alpha}=\frac{c}{b}$$

whence

$$x_\alpha=\frac{bx_2+cx_3}{b+c}\cdot$$

Let x_I, y_I be the coordinates of I. Since CI bisects $\angle ABC$

$$\frac{AI}{I\alpha}=\frac{AC}{C\alpha}=\frac{b+c}{a}\cdot$$

Therefore

$$\frac{b+c}{a}=\frac{x_I-x_1}{x_\alpha-x_I}=\frac{x_I-x_1}{(bx_2+cx_3)/(b+c)-x_I}$$

$$\therefore ax_I-ax_1=bx_2+cx_3-(b+c)x_I$$

or

Similarly
$$\left.\begin{aligned} x_I &= \frac{ax_1+bx_2+cx_3}{a+b+c} \\ y_I &= \frac{ay_1+by_2+cy_3}{a+b+c} \end{aligned}\right\} . \tag{2}$$

Apply Eq. 2 to find the position of the Incenter K of the Quarter triangle DEF (Fig. 2). Replace a, b, c by $a/2$, $b/2$, $c/2$ respectively and x_1, x_2, x_3 by $\frac{1}{2}(x_2+x_3)$, $\frac{1}{2}(x_3+x_1)$, $\frac{1}{2}(x_1+x_2)$ respectively. Let x_K, y_K be the coordinates of K. Then

$$x_K = \frac{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)}{2(a+b+c)} . \tag{3}$$

Similarly for y_K.

The Straight Line joining the Incenters I, K of the triangles ABC, DEF respectively (Fig. 5). The equation of this line is given by

$$\frac{y-y_K}{y_I-y_K} = \frac{x-x_K}{x_I-x_K} .$$

G the center of gravity of the full triangles ABC and DEF will lie on this line if on substitution of the coordinates of G for x and y in this expression the left hand side equals the right hand side.

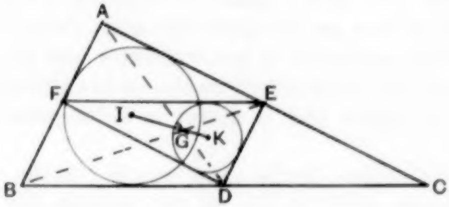

FIG. 5

On making this substitution the right hand side becomes

$$\frac{\dfrac{1}{3}(x_1+x_2+x_3)-\dfrac{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)}{2(a+b+c)}}{\dfrac{ax_1+bx_2+cx_3}{a+b+c}-\dfrac{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)}{2(a+b+c)}}$$

$$=\frac{\dfrac{2}{3}(x_1+x_2+x_3)(a+b+c)-\left\{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)\right\}}{2(ax_1+bx_2+cx_3)-\left\{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)\right\}}$$

$$=\frac{1}{3}\,\frac{2(x_1+x_2+x_3)(a+b+c)-3\{a(x_2+x_3)+b(x_3+x_1)+c(x_1+x_2)\}}{a(2x_1-x_2-x_3)+b(2x_2-x_3-x_1)+c(2x_3-x_1-x_2)}$$

$$=\frac{1}{3}\,\frac{a(2x_1-x_2-x_3)+b(2x_2-x_3-x_1)+c(2x_3-x_1-x_2)}{a(2-x_2-x_3)+b(2x_2-x_3-x_1)+c(2x_3-x_1-x_2)}$$

$$=\frac{1}{3}\,. \tag{4}$$

A similar set of equations shows that the left hand side is also equal to $\frac{1}{3}$. Therefore G lies on the straight line IK. Also since

$$x_G-x_K=\tfrac{1}{3}(x_I-x_K),\qquad GK=\tfrac{1}{3}IK,$$

so that G divides the line IGK such that

$$IG=2GK. \tag{5}$$

(6) *The Geometrical Argument.* The triangles ABC, DEF are similar triangles, their linear dimensions being in the ratio $1:\frac{1}{2}$.

G is common to both triangles; therefore $GI=2GK$, GI and GK being two corresponding lines.

If the triangles ABC, DEF were in similar positions, the slopes of GI and GK would be the same; but the triangle DEF is reversely placed relative to the triangle ABC; therefore if GI slopes upwards in the triangle ABC, GK slopes equally downwards in the triangle DEF. Therefore, I, G, K line on a straight line and $GI=2GK$.

The Geometric argument is much shorter and prettier than the Analytic argument but the latter enables us to calculate the positions of the different points and is useful in subsequent arguments in Mechanics.

Further considerations. In the same way if L is the Incenter of the quadruple triangle PQR, it lies on the straight line IGK and $GL=2GI$. This is illustrated in Fig. 6 where for further separation of these points a tall narrow isosceles triangle is taken.

(7) *The Length of GI:* Geometry and Trigonometry show that if as in Fig. 7, O, H, G and I are the circumcenter, orthocenter, centroid and incenter of the triangle ABC respectively the points O, G, H lie on a straight line (the Euler line) and $OG=\frac{1}{3}OH$. Thus it is possible to find GI if OH, HI and IO are known. We use the well-known expression exemplified in the equation

$$a^2=b^2+c^2-2bc\cos A.$$

Apply this to triangle GIO and we get

$$OI^2=GI^2+OG^2-2GI\cdot OG\cos\angle OGI.$$

Substitute for OG in terms of OH

$$\therefore\ OI^2 = GI^2 + \tfrac{1}{9}OH^2 - 2GI \cdot \tfrac{1}{3}OH \cos \angle OGI. \tag{6}$$

In the same way if we use the triangle GHI

$$HI^2 = GI^2 + \tfrac{4}{9}OH^2 - 2GI \cdot \tfrac{2}{3}OH \cos \angle HGI. \tag{7}$$

Multiply equation 6 by 2, remember $\cos \angle OGI = -\cos \angle HGI$, and add to equation 7. We get

$$2OI^2 + HI^2 = 3GI^2 + \tfrac{2}{3}OH^2 \tag{8}$$

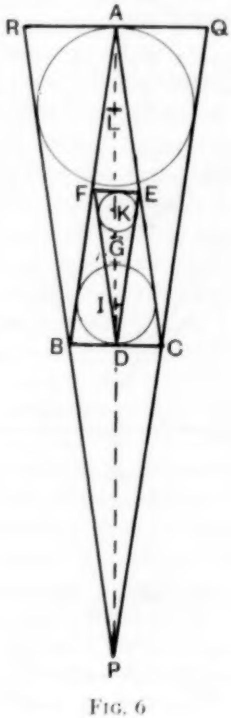

FIG. 6

so that

$$GI^2 = \tfrac{1}{9}(6 \cdot OI^2 + 3 \cdot HI^2 - 2OH^2). \tag{9}$$

Now Trigonometry[1] shows that:

$$OI^2 = R^2 - 2Rr$$

[1] A convenient reference is the article by John Satterly entitled "The Circumcircle, Incircle, Nine-points circle and the Circle ($\alpha\beta\gamma$) through the feet of the Bisectors of the Angles of a Triangle" in SCHOOL SCIENCE AND MATHEMATICS, Vol. LVI, No. 7. Whole No. 495, Oct. 1956.

$$HI^2 = 2r^2 - 4R^2 \cos A \cos B \cos C$$
$$OH^2 = R^2(1 - 8 \cos A \cos B \cos C)$$

where R, r are the radii of the circumcircle and incircle of the triangle ABC.

On subsitution of these values of OI^2, HI^2, OH^2 in Eq. 9 we get:

$$\begin{aligned} GI^2 &= \tfrac{1}{9}\{6(R^2 - 2Rr) + 3(2r^2 - 4R^2 \cos A \cos B \cos C) \\ &\quad - 2R^2(1 - 8 \cos A \cos B \cos C\} \\ &= \tfrac{1}{9}\{6(R-r)^2 - 2R^2 + 4R^2 \cos A \cos B \cos C\}. \end{aligned} \tag{10}$$

Alternative expressions for GI^2 are

$$GI^2 = \frac{16}{3} R^2 \left(\sum \sin^2 \frac{B}{2} \sin^2 \frac{C}{2} - \frac{1}{12} \sum \sin^2 A \right) \tag{11}$$

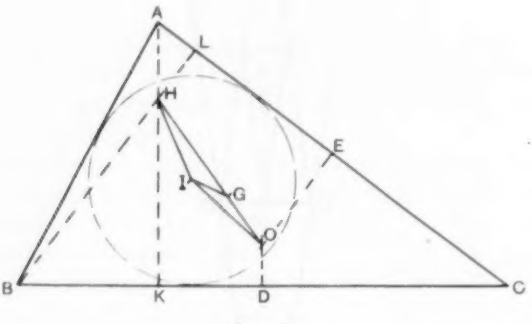

FIG. 7

and

$$\begin{aligned} GI^2 &= \frac{1}{3}(bc + ca + ab) - \frac{1}{9}(a^2 + b^2 + c^2) - 4Rr \\ &= \frac{2}{3} s^2 - \frac{5}{18}(a^2 + b^2 + c^2) - \frac{abc}{s} \end{aligned} \tag{12}$$

where $2s = a + b + c$. These are given by Hobson[2] as problems. Equation (10) is new.

A conveniently shaped triangle for the illustration of the above points is that which I have called the Hope-Jones Triangle. It is the one shown in Fig. 7. The sides are $a = 16.8$, $b = 15.0$, $c = 10.2$; the radii are $R = 8.5$, $r = 3.6$, and $\cos A$, $\cos B$, $\cos C$ are $13/85$, $8/17$, $4/5$ respectively. Here $OI^2 = 11.05$, $HI^2 = 9.28$, $OH^2 = 38.97$ and $GI^2 = 1.80$. All numbers quoted are exact.

[2] E. W. Hobson, Plane Trigonometry (Cambridge University Press), 1911, 3rd edit., p. 200, Ex. 3.

A PHYSICAL SCIENCE CLASS CHECKS AN ADVERTISING CLAIM

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Most science educators will agree that every science student should be exposed to some problem-solving experiences, preferably with apparatus. There has been much justifiable condemnation by science educators of the so-called "cook book" method of laboratory instruction. However, it is often difficult to devise situations or problems in which the answer cannot be obtained from textbooks or references; it is even often difficult to subject such problems to the experimental test in a school environment. Nor is it always possible to find problems that are simple enough for the beginner so that even a pupil with a very limited background can tackle them with enthusiasm and profit. The closer the problem approximates the type that a scientist might meet in actual practice, the more likely it is that the student will get a true perspective of scientific methodology. The writer has found that many advertisements serve as an excellent source of problems which can be used as individual or class projects to provide students with experience in the use of the experimental method and practice in developing scientific attitudes.

In general, advertising men know that people have great respect for the achievements of science and the objectivity of science. Consequently, much of the advertising copy in newspapers, magazines, radio, and TV contains a great deal of scientific or pseudoscientific vocabulary. Frequently, laboratory investigations are described in greater or lesser detail, and occasionally the reader is asked to verify the superiority of the advertised item by an actual test or comparison with a competitor's product. Typical of the statements in recent advertisements are: "Scientific Tests Prove . . . " (Zenith); "First to Give You Scientific Facts" (Chesterfield); "Science Discovers New Easy Way" (Kyron); "These Careful Experiments by Reputable Scientists Give the Facts" (Ipana); "Cold Water Test Proves" (Nestle's); "You Can Prove It Yourself" (Colgate); "Make the Separation Test—You Can *See* It's Best" (Bird's Eye); "Verified by Leading Laboratory Consultants" (Lucky Strike). In some of the advertisements the sampling or testing technique is so obviously biased that most high school chemistry or physics students will be able to find the flaws. In many cases the leading statement is correct, but entirely irrelevant to the conclusion about the quality or properties of the product. Often no test is described or is at all possible or meaningful. But practically every "scientific ad" will provide material for fruitful class discussion and/or experimentation.

During the Winter Quarter of 1954, a student in the writer's general education Physical Science class at the University of Minnesota questioned the validity of the "Minute Maid" advertisement. The advertisement raised the questions: "Pediatricians know the answers . . . do you? Which Orange Juice Is Better for Baby's Health?" and the given answer was: "Minute Maid . . . because penny for penny, it will give baby decidedly more vitamin C." The writer suggested that the class investigate the problem experimentally. The advertisement was reproduced by the offset method and each member of the class was given a copy. In class discussion it was decided to limit the experimental part of the problem to a comparison of the amount of vitamin C in a penny's worth of Minute Maid and a penny's worth of orange juice squeezed from the fruit. The problem as formulated by the members of the class was: "Which contains more Vitamin C, a penny's worth of Minute Maid fresh-frozen orange juice or a penny's worth of home-squeezed orange juice?" The writer proposed that the actual testing for Vitamin C content be done during the regular two-hour laboratory period. The directions for the laboratory exercise are given below.

Laboratory Exercise on Vitamin C

Objectives

1. To determine chemically the ascorbic acid content (vitamin C) in samples of freshly prepared orange juice and of frozen concentrate.
2. To compare the cost of ascorbic acid in the two samples.

Apparatus and Reagents

1. Pipette, 10 ml
2. Burette, 50 ml
3. Funnel and support
4. Beakers
5. Stirring rod
6. Fresh and frozen orange juice
7. 2,6-dichlorophenolindophenol solution
8. Ascorbic acid standard solution
9. Filter paper

Theory

The vitamin C activity of a substance is directly related to the amount of ascorbic acid in it. One of the simplest methods for determining the ascorbic acid content of a solution is based on the reducing properties of the acid. In the presence of an oxidizing agent, such as an indophenol dye, ascorbic acid is oxidized while the agent is reduced. The change in the color of the ascorbic acid solution indicates the completion of the process.

Pure ascorbic acid is available in soluble form. Therefore, a standard solution can be prepared for standardizing a dye solution. The latter can be used for determination of ascorbic acid content of fruit

TABLE 1

ASCORBIC ACID CONTENT OF ORANGE JUICE. PHENOLINDOPHENOL TITRATION DATA FROM ONE LABORATORY SECTION OF NATURAL SCIENCE

March 1, 1954—1:30–3:30 P.M.

Observer	Volume of Dye for 10 ml of Sample		
	Source of Ascorbic Acid		
	Standard Solution	California Fresh Oranges	Minute Maid Frozen Concentrate
Buckley	9.50 ml	10.20 ml	7.00 ml
Kobul	9.50	10.50	6.50
Benson	9.50	10.80	6.50
Piotraschke	9.40	9.90	6.70
Piepho	9.60	10.50	7.30
Brewer	9.40	11.20	6.60
Thomson	9.40	10.90	7.40
Gauger	9.80	10.80	7.50
Jacobson	9.50	10.50	8.60
Kuharski	9.70	10.50	8.50
Kroening	9.40	10.40	8.10
Mean	9.52	10.6	7.34
S.D.	.10	.44	.70

juices and other sources of vitamin C. Since ascorbic acid is unstable in solutions, these are generally stabilized with metaphosphoric, acetic, or oxalic acids.

Procedure

1. Place 10 ml of standard ascorbic acid solution in a small beaker
2. Titrate the standard solution sample with the dye solution from the burette. Stir continuously until the solution turns pink and the color persists for 15 seconds. Record the amount of dye solution used. Obtain from the instructor and record the following data
   a. The concentration of ascorbic acid in the standard solution
   b. The concentrations of the fresh and frozen orange juice solutions
   c. Type of oranges, cost, volume of juice, etc.
3. Place 10 ml of filtered fresh orange juice solution in a small beaker and titrate with the dye solution. Record
4. Repeat 3 with frozen orange juice
5. Calculate
   a. The amount of ascorbic acid represented by 1 ml of the dye solution

b. The amount of ascorbic acid represented by 1 ml of the fresh orange juice
c. The amount of ascorbic acid represented by 1 ml of the frozen orange juice
d. The amount of ascorbic acid in one penny's worth of fresh juice
e. The amount of ascorbic acid in one penny's worth of frozen juice

Applications

1. Look up the daily minimum requirements of vitamin C for children and adults.
2. One ounce of pure ascorbic acid can be bought for about $1.00. How many oranges would be required to yield that amount of ascorbic acid? Cost? How many cans of frozen juice? Cost?
3. Make a brief analysis of the ***Minute Maid*** advertisement

The indophenol dye used in the experiment was made by dissolving 250 mg of sodium 2,6-dichlorophenolindophenol (also called sodium 2,6-dichlorobenzenoneindophenol) in about 750 ml of hot distilled water containing 200 mg of $NaHCO_3$, allowing the solution to cool and diluting it with distilled water to make one liter. The solution was kept in a brown bottle and stored in a refrigerator when not in use.

The standard ascorbic acid solution was prepared by dissolving 500 mg of L-ascorbic acid in 500 ml of distilled water and adding 500 ml of 2% oxalic acid solution to minimize the oxidation of the vitamin by interfering substances such as protein and ferric ion. The solution was also stored in the refrigerator when not in use. The indophenol dye and the ascorbic acid are available from any chemical supply company.

The indophenol solution is standardized by titrating 10 ml of standard ascorbic acid solution. The standardized dye is then used to determine the ascorbic acid content of orange juice. Thus, if 9.50 ml of dye and 7.00 ml are needed respectively to titrate 10 ml of standard ascorbic acid solution and 10 ml of frozen orange concentrate, then the ascorbic acid content of the concentrate is:

$$\frac{500 \text{ mg}}{1000 \text{ ml}} \times \frac{10 \text{ ml}}{9.5 \text{ ml}} \times 7.00 \text{ ml} = 3.7 \text{ mg}.$$

The titration should be completed as quickly as possible, preferably in less than 2 minutes. For high precision determinations it is also necessary to use glass distilled water so as to avoid interference due to copper. However, ordinary distilled water was used in the class project since the errors due to the possible presence of interfering

substances in this water would not alter appreciably the approximate ratio of the ascorbic acid in the two samples.

The students were familiar with the process of titration through a lecture-demonstration on ionization and neutralization. However,

TABLE 2

ASCORBIC ACID CONTENT OF ORANGE JUICE. PHENOLINDOPHENOL TITRATION SUMMARY FOR SIX LABORATORY SECTIONS OF NATURAL SCIENCE

Date (1954)	N	Source of Ascorbic Acid	Preparation	Ascorbic Acid		
				Concentration	Cost/ml	Amount/¢
Feb. 23	14	Florida juice oranges	Freshly squeezed and diluted	.40 mg/ml	.041¢/ml	9.8 mg/¢
Feb. 23 1954	14	Minute Maid frozen concentrate	Freshly diluted can No. 1	.50	.022	23
Feb. 24	12	Florida juice oranges	Freshly squeezed Feb. 23, diluted and stored in refrigerator 24 hrs.	1.0	.041	25(?)
Feb. 24	12	Minute Maid frozen concentrate	Diluted Feb. 23 and stored in refrigerator 24 hrs.	.53	.022	24
Mar. 1	11	California Sunkist eating oranges	Freshly squeezed and diluted	.56	.11	5.0
Mar. 1	11	Minute Maid frozen concentrate	Freshly diluted can No. 2	.39	.022	18
Mar. 1	13	California Sunkist eating oranges	Freshly squeezed and diluted. 3 hrs. at room *t*	.5	.11	4.4
Mar. 1	13	Minute Maid frozen concentrate	Freshly diluted can No. 2. 3 hrs. at room *t*	.34	.022	15
Mar. 2	11	Florida Juice orange	Freshly squeezed and diluted	.44	.039	11
Mar. 2	11	California Sunkist eating oranges	Freshly squeezed March 1, diluted and stored in refrigerator 24 hrs.	.63	.11	5.6
Mar. 2	11	Minute Maid frozen concentrate	Diluted March 1, and store in refrigerator 24 hrs. can No. 2	.43	.022	20
Mar. 3	10	Florida Juice oranges	Freshly squeezed and diluted	.40	.041	9.8
Mar. 3	10	Florida Juice oranges	Freshly squeezed Mar. 2, diluted, and stored in refrigerator 24 hrs.	.39	.041	9.5
Mar. 3	10	Minute Maid frozen concentrate	Diluted Mar. 1 and stored in refrigerator 48 hrs. No. 2 can	.35	.022	16

because of their limited laboratory background, the students experienced some difficulty in determining the end point.

Two types of oranges were used: Florida juice and California Sunkist. Oranges were squeezed by hand on a glass squeezer. The concentrate was diluted with tap water according to directions on the can. All juice was diluted to 20% concentration in 1% oxalic acid solution. The diluted juice was filtered before titration. Each student worked independently. The data for each laboratory section was tabulated and averaged. A typical set is shown in Table 1. The summary of results for all the sections is reproduced in Table 2. The data and the summary were dittoed and distributed to all members of the class. A table of Recommended Vitamin C Daily Requirement was also distributed.

After completion of experimental work a class period was set aside for discussion of results and an analysis of the advertisement. The students concluded from the data that (1) there was good experimental evidence, with one exception, that there was more vitamin C in a penny's worth of ***Minute Maid*** concentrate than in a penny's worth of home-squeezed juice; (2) the one exception—the data of February 24, 1954—was probably caused by some systematic error, since a repetition of the test with new solutions gave results which were consistent with other samples; (3) there were variations in vitamin C content between oranges of the same brand and between cans of the same concentrate; (4) the *cost* of the equivalent amount of vitamin C was highest for California Sunkist oranges, least for the frozen concentrate; (5) the concentration of vitamin C per unit *volume* of the juice was highest for the Sunkist oranges and about equal in the Florida oranges and the concentrate.

Members of the class also contributed the following observations concerning the Minute Maid advertisement: (1) the question of taste might be an important consideration; the taste factor was completely neglected; (2) the advertisement implies that parents will place economy above the baby's health; (3) the cost factor is entirely irrelevant to the question raised in the advertisement; (4) the cost of synthetic ascorbic acid was so low that the baby's minimum daily requirement could be met by adding this important vitamin in milk or other foods at a fraction of a penny per day. Therefore the ad's appeal to economy was biased. (5) if the baby consumes only a limited volume of orange juice, then there is a greater probability of the baby getting *less* vitamin C from the frozen concentrate than from the freshly squeezed California oranges.

As a follow up of the experiment students were also asked to analyze and submit a written report of some other advertisement that used "Scientific Proof." Many of the reports were good and showed

an understanding of the several evaluation criteria brought out during the class discussion of the Minute Maid advertisement.

Thus, with practice in critical evaluation and experimental testing of scientific advertising claims, it is quite likely that physical science students will (1) develop an alertness to the use and misuse of science terminology; (2) grow in their ability to detect biased or incomplete data; (3) gain first hand experience with experimental methodology; (4) see more cogently the relationship between class work and their immediate environment.

The science teacher will find examples of advertisements in the daily press, magazines, radio and TV which may be used as class or individual projects for the creative teaching of the experimental method.

References

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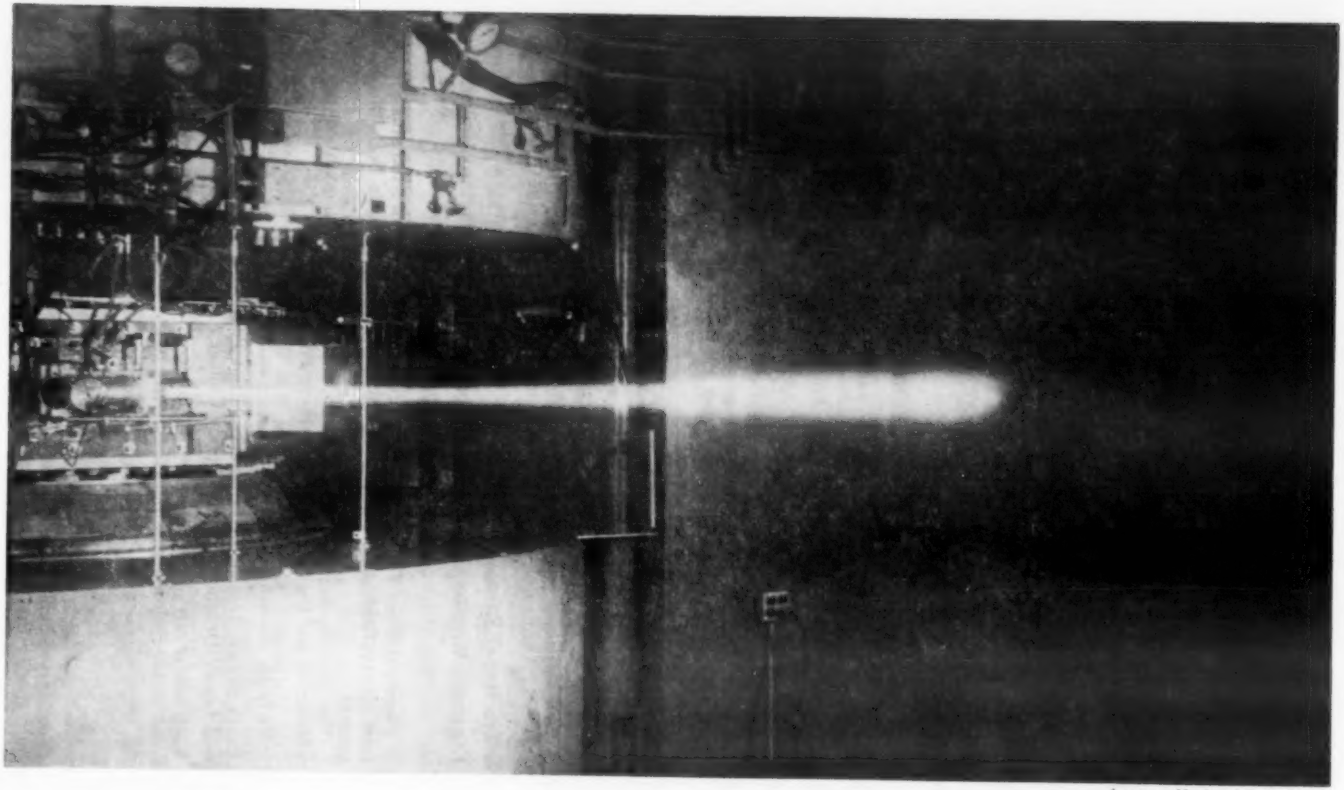

Argonne National Laboratory

(See page 383 for legend)

HIGHLIGHTS OF THE 1957 CONVENTION PROGRAM

1. THE ARGONNE NATIONAL LABORATORY TOUR

Louis Panush

Vice President, CASMT, 3437 Oakman Blvd., Detroit 4, Michigan

It is our intention during the next few months to bring to the attention of the membership and friends of *Central Association of Science and Mathematics Teachers,* and especially to all prospective convention attendees, the highlights and the most important features of the forthcoming 1957 convention in Chicago.

This year we have departed from the traditional program structure by shifting the section meetings to Saturday morning, November 30 and providing two extremely worthwhile tours for Friday afternoon. One will be to the nation's senior atomic energy laboratory, the *Argonne National Laboratory,* which is operated by the University of Chicago under contract with the U. S. Atomic Energy Commission.

To quote from official literature: "The Argonne National Laboratory is organized so that highly skilled scientists and engineers may carry on necessary research and development in the vital areas (biology and medicine, chemistry and physics, and theoretical and experimental knowledge in atomic energy phenomena). Each of the Laboratory's divisions is equipped with the (manpower), facilities and tools needed for effective creative and development work in its own field."

We shall see this new and complex atomic energy business operated by some 600 scientists and engineers. We hope to become acquainted thoroughly with one or more of the divisions. We shall see delicate experiments in progress, the research reactor in action, and the new EBWR (experimental boiling water reactor), which is used for the generation of power from nuclear fuels, at work. Local, authoritative personnel will be on hand to guide, to describe, to demonstrate, and to answer questions.

Below is a brief outline of the tour's schedule:

12 noon. Busses will leave the hotel for ANL. Participation is limited to 200. Pre-registration will be required. Information on the cost of transportation and lunch will be forwarded later.

1:10–2:00. A nutritious and inexpensive lunch in the Laboratory's cafeteria.

The tour will last three hours, followed by a half-hour discussion period. Each

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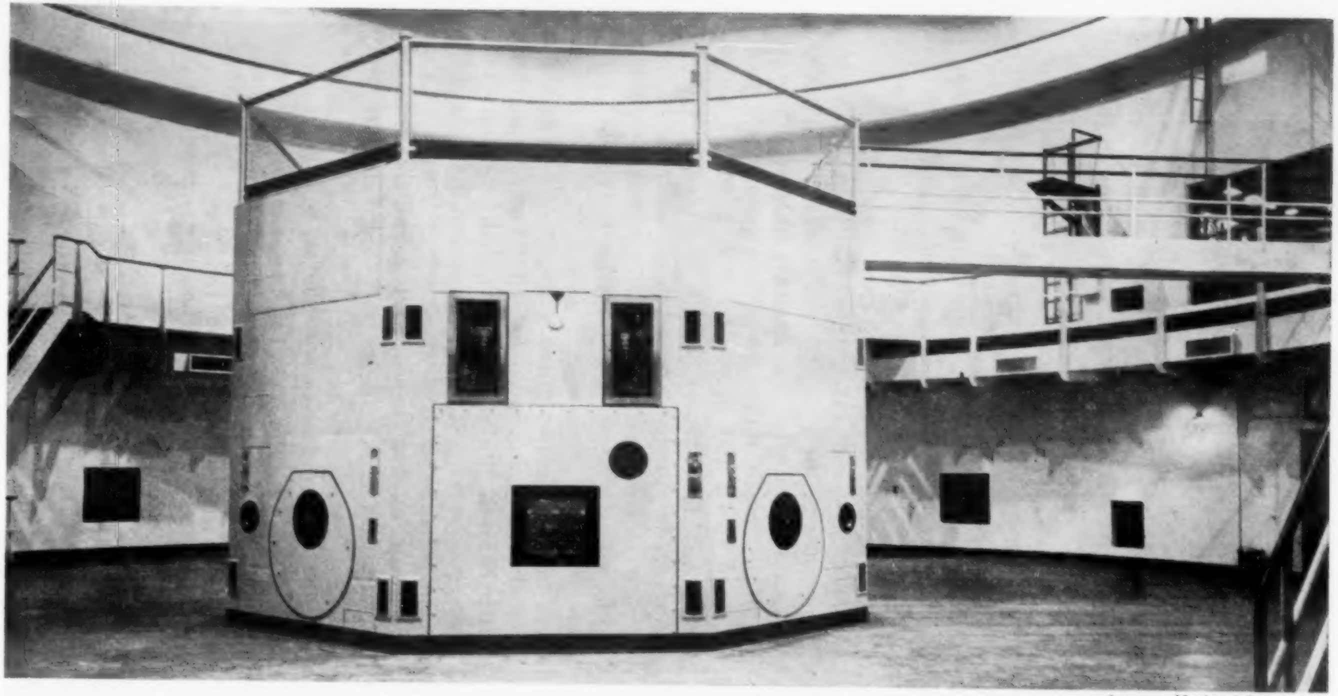
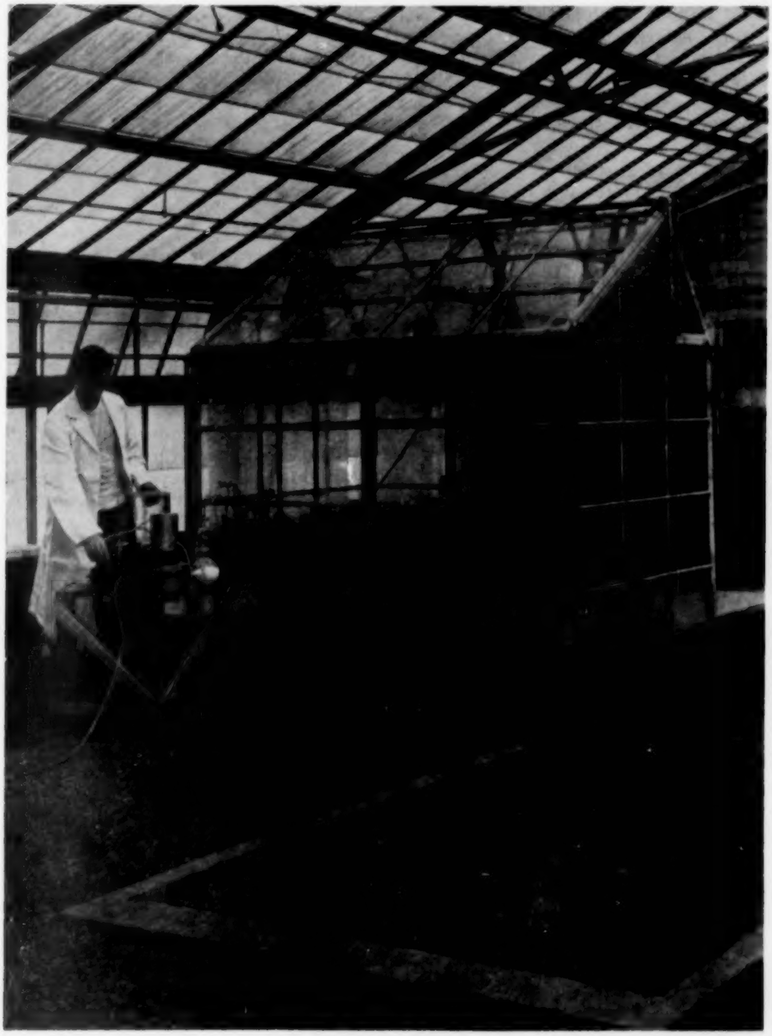
Shown is a beam of deuterons emerging from the acceleration chamber of Argonne National Laboratory's new 60" cyclotron. The deuteron beam is visible (in a dark room) because of the light given off when the deuterons strike air molecules. The beam path in air is about 11 feet. This picture was made by photographing the cyclotron through a 7 foot thick window filled with zinc bromide solution. Argonne Photograph No. 388.



Argonne National Laboratory

Shown is the Atomic Energy Commission's newest research reactor which was recently placed in operation at Argonne National Laboratory at Lemont, Illinois. The reactor, which uses uranium^{235} as its fuel and is cooled and moderated by heavy water, resembles a concrete octagonal prism twenty feet wide and thirteen and one half feet high. Access to the neutrons created within the reactor is made possible by more than fifty openings which penetrate the eight sides and top of the reactor. Operation of the reactor is controlled by technicians in the control room (upper right) overlooking the reactor.



Producing radioactive plant products at the Argonne National Laboratory is accomplished by feeding them radioactive carbon dioxide while they grow in the sealed chamber shown above. It has been developed to expedite studies of a number of the processes occurring in plants. Dr. Norbert J. Scully of the Laboratory's Radiobiology Experiment Station observes the plants' development. By substituting a radioactive form of carbon dioxide for the carbon dioxide normally used by a plant, all carbon-containing products of the plant will be radioactive. The radioactive gas is generated in the flask at left. Cold water flows over the sealed chamber in order to maintain a constant temperature of 72°F. inside the chamber. Argonne Photo No. 125.

of the four bus-loads of 45 passengers will be handled as a unit, stopping for forty-five minutes at each of four places. Five places will be available, and there will be an option between two of them for each bus-load.

2:00–2:45. Building 330—CP-5, the ***Laboratory Research Reactor.*** It operates at a thermal level of 2000 kva, produces neutrons for experimental purposes and irradiates samples for use at Argonne and elsewhere. Experiments in progress include measurements of neutron velocities, gamma ray energies and wave lengths, neutron-electron interactions, crystal structure, shielding capacities of various materials. The design of the reactor will be explained; the equipment, operation and experiments in progress—described.

2:45–3:30. Building 331—EBWR, the ***Experimental Boiling Water Reactor,*** the first reactor in the A.E.C.'s power reactor program to be completed. It is a direct-cycle boiling, 20,000 kilowatt (heat) reactor which provides the energy for generating 5,000 kw electricity which is used by the Laboratory. The EBWR was recently dedicated to the peace and prosperity of mankind.

3:30–4:15. Bldgs. 310 and 308. ***Gamma Irradiation Facility,*** demonstrating a high-intensity source of gamma rays irradiating food products in studies on preservation of foods by radiation, and the ***Liquid Sodium Reactor Test Equipment*** facilities and testing work.

Or, Bldgs. 60 and 24, the ***greenhouse*** where the up-take of radio-active carbon (in CO_2) by plants will be shown and a demonstration of various operations will be given with the "master-slave manipulators"—a completely electronic unit for use in sealed radiation caves to perform various operations remotely.

4:15–5:00. Bldg. 202, the ***Biological*** and ***Medical Research Division*** where will be shown the ultra-violet microscope, plant growth rooms (controlled conditions of light, heat and humidity), animal quarters (housing experimental laboratory animals subjected to regulated conditions of heat, light, etc.), and X-ray machines, housed in a room shielded with lead (they produce penetrating x-rays for radiation experiments on animals).

5:00–5:30. General conference in Building 200. Question and answer period and summary, with Mr. Earl W. Phelan, Staff Assistant, ANL, in charge. Incidentally, Mr. Phelan was most cooperative in arranging and scheduling the details of this tour.

5:30. Return to hotel; ***or,*** first dinner at the Laboratory cafeteria (to be decided by participants) and then return to hotel for the evening's general session.

A formidable tour, an enlightening experience—one we will not forget.

TEACHER AWARDS PROGRAM

Six undergraduate college teachers will be chosen in the next few months to receive $1,000 awards for outstanding teaching of chemistry. This 1957 MCA Awards Program has been established to recognize and reward teachers who have been outstandingly successful in their instruction endeavors and to call public attention to the importance of good teaching in the field of chemistry. A panel of five judges will be announced shortly and all presidents of eligible colleges and universities will then be sent invitations to submit nominations of candidates from their staff. Awards will be announced in late May and will be presented to the winners at MCA's annual meeting at White Sulphur Springs, W. Va., June 6.

"I'll put a girdle around the earth in forty minutes."

—PUCK in ***Midsummer Night's Dream***

Slow Puck! if Puck had lived today—.

A CARTESIAN DIVER*

(NUMBER ONE IN A SERIES)

HARALD C. JENSEN
Lake Forest College, Lake Forest, Illinois

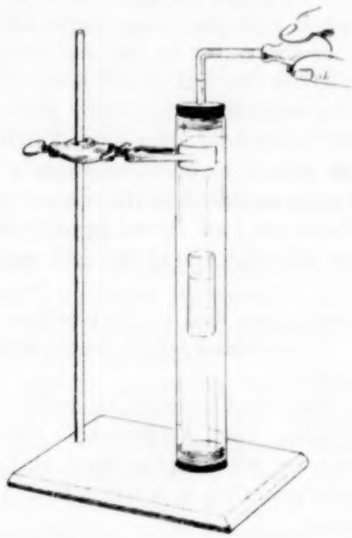


FIG. 1. Sketch of large scale Cartesian Diver.

*EDITORIAL NOTE: SCHOOL SCIENCE AND MATHEMATICS is initiating a series of descriptions of physics demonstration experiments selected with the following objectives and purposes in mind:

1. To revitalize and modernize old, but important ways of presenting some of the fundamental concepts in physics.
2. To present new ways of demonstrating basic principles and concepts.
3. To show how the apparatus for certain demonstrations may be enlarged to enhance teaching utility.
4. To simplify the apparatus required in some cases.
5. To modify the apparatus in order to reduce the number of accessories needed for adequate presentation.
6. To make suggestions for inexpensive and "home made" equipment.
7. To call attention to supplies and apparatus not available from the conventional sources.

Note that the descriptions are not necessarily to be presented for their originality, newness, or uniqueness, but in an attempt to help physics instructors in the schools accumulate a set of devices serving to enrich his motivating and teaching skills.

Many of these demonstrations will be suitable for exhibit or museum pieces for operation by the individual student. It is suggested that they be placed in a convenient place, one at a time, with appropriate directions.

It is intended that information concerning the sources of material and details of construction be made explicit so that the instructor can reproduce the demonstrations without undue difficulty.

To construct the modified form of Cartesian Diver shown in figure 1, obtain a piece of glass tubing[1] about $1\frac{1}{2}$ feet long with outside diameter of 32 mm. After both ends are fire-polished, one end is closed with a #6 solid rubber stopper. The tube is supported with its axis vertical by means of a burette clamp and ringstand, then filled with water. A clean, empty litmus paper vial is also filled with water, inverted, and dropped into the long, water-filled tube in such a manner that some of the water in the vial escapes. If the correct amount of water is left in the vial, it will float with its top just even with the surface of the water in the long tube. Success with this manipulation will probably come only after several trials.

Now a right angle glass tube is inserted into a one hole #6 rubber stopper and the stopper is placed in the upper end of the long tube. A rubber pipette bulb[2] of 5 or 10 ml capacity or a bulb from an atomizer is placed on the other end of the right angle tube, completing the apparatus.

Featuring easy operation and positive action, this apparatus is well suited for the type of exhibit which the student can operate at his convenience and leisure.

It is well known that the Cartesian Diver can be used to demonstrate several principles: viz., Archimedes', Pascal's, Boyle's, and that of pressure increase with depth. Since this apparatus is large, easily seen, and easily operated, it is well adapted for use in teaching any of these principles.

[1-2] These items can be obtained from any supplier of science apparatus.

CANCER-PRODUCING SUBSTANCES

Everyday contact with cancer-producing substances called carcinogens is providing an "increasingly great danger to the health of man," according to Prof. R. K. Boutwell of the University of Wisconsin's McArdle Memorial Laboratory.

"The main solutions to the problem are, first, to lessen the exposure of man to these agents and, second, to learn how to make ourselves resistant to their effects," he adds.

Boutwell claims that polluted air is a common carrier for many carcinogens—soot, oxidized products of gasoline vapors, and radiation—and "taken singularly, below the chemical's threshhold, each one of these substances may have little effect."

"But," Boutwell asks, "when they combine forces, can certain carcinogenic agents in man's environment supplement each other—as has been shown with mice?

"This question may never be fully answered," he says, "but the possibility emphasizes the need for everyone to avoid exposure to carcinogenic influences whenever possible."

Scientists have observed a tremendous variation between susceptibility rates of individuals exposed to the same carcinogenic agents.

One of the great unsolved riddles of cancer is how to provide all persons with the resistance now shown by some, Boutwell points out.

NEEDED RESEARCH IN THE TEACHING OF SCIENCE AND MATHEMATICS

REPORT OF THE PROJECTS AND RESEARCH COMMITTEE

H. Vernon Price
State University of Iowa

Following the meeting of the Board of Directors of CASMT on May 5, 1956, and at the direction of the Board, President Charlotte Junge appointed the following Projects and Research Committee:

Ralph Huffer, Beloit College, Beloit, Wisconsin
Jacqueline Buck Mallinson, Kalamazoo, Michigan
H. Vernon Price, Iowa City, Iowa, *Chairman*

The primary duty of the committee was "the study of research needed in the areas of Science and Mathematics and the recommendation to the Board of Directors of a research project or projects which the Association might well undertake."

The Committee members shared the belief that one of the most promising procedures for determining the needed research was to seek the counsel of leaders in the field who were close to, and cognizant of, current problems. Consequently, a group including members of the Board, association officers, and a cross-section of other leaders of CASMT, was approached with a questionnaire. The unedited replies constitute the report which follows:

Question 1:

What research do you believe is needed in the area of Science and Mathematics?

Replies:

1. What type of academic background makes for the best teacher of science or mathematics?
2. What types of abilities, psychological and physical, are needed for success in science and mathematics?
3. Out-dated topics in today's science and mathematics courses.
4. Research on the problem of whether or not large sized classes (that is, classes of 150 or over) can be successfully used in science and mathematics, without detriment to the student or the course content.
5. What mathematics is needed in high school science?
   a. What is necessary as courses are taught now?
   b. What *would be used* in science courses if it were taught?
6. What revisions are needed in the high school and junior college mathematics programs in order to incorporate desirable contributions from the content of modern mathematics? (Ditto for science)
7. What types of teacher training programs can be most effective in keeping teachers of secondary mathematics aware of and basically informed in the more significant modern developments in the field of mathematics?
8. What program might CASMT organize and promote to help teachers of secondary mathematics keep informed in modern developments in mathematics?

9. Collect for mathematics classes (insert in texts) problems that will appear in Physics and Chemistry texts—word problems which require intelligent reading and reasonable analysis.
10. Study of the textbooks in Chemistry and Physics. (As the subjects grow the textbook writers and publishers try to include everything, leaving the poor teacher in a daze and the students get little and that little is vastly different from school to school).
11. The creation of (a) a list of teaching units in (secondary school) mathematics, (b) a list of their applications, "accepted" and unique, (c) the level of intelligences using the applications, and (d) creation of vocational guidance experience teaching units.
12. Studies to determine the relationship between teacher preparation and teacher's success.
13. Studies to determine the relationship of preparation of teachers and attitudes toward teaching.
14. Studies dealing with content; for example, the general mathematics approach versus the traditional approach and the resulting effect on ability gained and attitudes obtained.
15. What concepts can be mastered by various age groups—Primary, Intermediate, Upper Grade, High School?
16. How can each (Mathematics and Science) be taught more effectively?

Question 2:

List any projects which you consider to be important and which relate science and mathematics—projects which are suited to Central Association's unique organization.

Replies:

1. What are the mathematical difficulties in high school chemistry and physics?
2. Why do high school pupils take science and/or mathematics?
3. A study of the principles of approximate computation and significant figures in problems relating to measurement. An agreement should be reached between the two groups.
4. What is a desirable minimum program in mathematics (science) for teachers of science (mathematics) in the high schools? In the junior colleges?
5. Develop short cuts in arriving at approximate answers.
6. There are some teachers yet who do not seem to realize that their subject reaches over into other fields, such as mathematics—physics—chemistry. Can anything be done to bring these groups together?
7. Could the Association run a series of articles in the journal designed to assist the teacher of mathematics or science to benefit from the other area?
8. Could there be a project dealing with equipment which is usable in both mathematics and science and some suggestions as to how this might be implemented?
9. A study of concepts which are presently being taught. Compare these with *what* should be taught. How can they be taught more effectively?

OAK RIDGE INSTITUTE EXPERIMENTS WITH DEMONSTRATIONS

The Oak Ridge Institute of Nuclear Studies is sponsoring an interesting experiment for improving demonstrations in science and interesting young people in scientific careers. Eight mobile units have been equipped with science demonstration equipment and a trained leader. These units will follow a scheduled plan, visiting schools in small communities where science teachers will be helped with their problems. The leaders also have equipment for giving popular lectures to parents and other adults on such topics as atomic energy.

A CONVENIENT METHOD FOR TEACHING LABORATORY TECHNIQUE

WESLEY W. WENDLANDT
Texas Technological College, Lubbock, Texas

A common procedure in many college and university first year courses in chemistry is to give prelaboratory instruction in some room other than the laboratory. Hence, the laboratory apparatus set-up is illustrated by a chalk drawing on the blackboard with the corresponding verbal instruction as to how to connect up the pieces of equipment. A more satisfactory method would be to connect up the actual pieces of equipment into the desired apparatus. However, this would be quite impractical as it would necessitate the carrying from room to room of the pieces of glassware, ringstands, burners, etc.

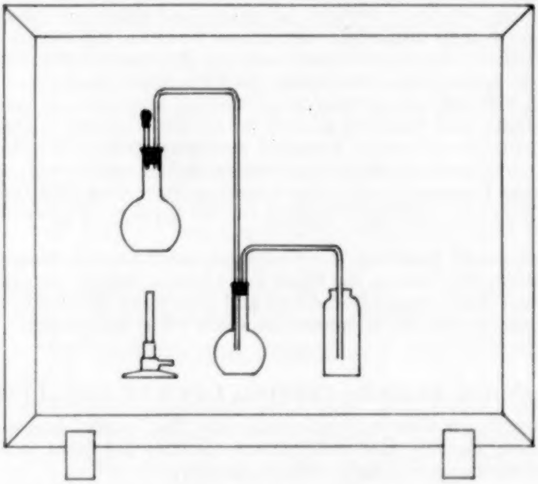


FIG. 1. A typical laboratory apparatus set-up.

A more satisfactory solution to this problem is to use cardboard cutouts of the pieces of equipment which have small magnets glued to the backside of them so that they can be attached to a metal surface. Actual lengths of glass tubing are then used to connect the various pieces of equipment together into the desired apparatus.

The use of this method is illustrated in Figure 1. The apparatus set-up is for the preparation of sulfur dioxide, a common laboratory experiment. The four major pieces of equipment, the Bunsen burner, the two Florence flasks, and the wide mouth bottle, were cut out of white cardboard. Small Alnico magnets, $\frac{3}{4}'' \times \frac{1}{4}'' \times 1''$, were glued to the back of them to serve as points of attachment. To make it possible

to connect the pieces of glassware together with glass tubing, corks were cut in half and glued to the necks of the flasks. Small holes were then drilled in the corks so that the glass tubing fit snugly. Besides the pieces of apparatus illustrated, a complete set of other common laboratory equipment was made up.

With the representative pieces of laboratory equipment available, any common laboratory apparatus set-up can be illustrated. Since the laboratory apparatus is built up of individual components, the student finds it much easier to build a similar set-up of actual equipment when he is required to do so in the laboratory.

PFIZER GIVES $1 MILLION IN 1956 FOR AID TO EDUCATION AND OUTSIDE RESEARCH

Grants made by Chas. Pfizer & Co., Inc. and the Pfizer Foundation to educational and medical institutions for individual financial aid, fellowships and support of scientific research last year totaled approximately $1,000,000.

Of this amount, students, resident physicians and pharmacy internes received $330,000 through their individual institutions for aid in the completion of their education. Medical schools, veterinary colleges, pharmacy colleges and hospitals throughout the country benefited under the Company's program.

The sum of $359,000 was granted to universities, hospitals and agricultural experiment stations, both here and abroad, for advanced studies in medical, chemical and agricultural technology. Included were projects involving basic research and application research in the fields of human and animal disease and nutrition. In addition, the Company made grants totaling more than $100,000 for fellowships, consultantships and contributions for the support of scientific organizations.

Besides the grants made by the Company, contributions totaling $207,000 were made during the year by the Pfizer Foundation. Among the recipients were national groups which support medical and pharmacy education and philanthropic organizations in the communities where Pfizer has plants.

ALCOHOL BREATH-TESTING DEVICES UNRELIABLE

Four University of Wisconsin scientists said that alcohol breath-testing devices now being used by law enforcement agencies are often inaccurate and should not be used as prima facie evidence in court.

Tests have proved the machines to be unreliable, they reported, and said chemical analysis of blood or urine by a qualified chemist is still the most foolproof method of determining whether a person is under the influence of alcohol.

The scientists are Dr. Frederick Shideman, chairman of the department of pharmacology and toxicology; Dr. Warren E. Gilson, assistant professor in charge of medical electronics and electroencephalography; Dr. Gilbert J. Mannering, assistant professor of pharmacology and toxicology and consultant in toxicology to the State Crime Laboratory and the State Department of Agriculture; and Dr. Frank Kozelka, professor of clinical pathology in charge of the clinical chemistry laboratories of the University Hospitals and the State Laboratory of Hygiene.

Dr. Mannering reported on tests of two breath-testing devices in the Medical School laboratories. Volunteers drank measured amounts of alcohol and were tested by both the blood analysis method and the breath-testing machines. The results did not always correspond, Dr. Mannering said, and in some cases the machines disagreed.

IN SEARCH OF HURRICANES

Maitland P. Simmons
Irvington High School, Irvington 11, New Jersey

In recent years many science-minded adolescents in this area are becoming increasingly interested in visiting and collecting data from weather stations for the specific purpose of constructing hurricane forecasting projects. A reason, perhaps, for this marked enthusiasm is to learn ways and means to reduce the continued devastation created by such notorious hurricanes as Carol and Diane.

The author[1] will now briefly describe one of these worthwhile pupil-teacher planned experiences. With the Greater Newark Science Fair only five months away, Glenn Shephard, a talented tenth-grade student, began collecting, classifying, and analyzing factual information from the various weather observation stations. From the findings the student set out to build and assemble a variety of brightly colored interest-creating instruments used to track and plot tropical storms. These include, as seen in the pictorial illustration, a whirled psychrometer, mecurial barometer, portable radio, radar, anemoscope, anemometer, and storm flags.

The psychrometer, which measures relative humidity, consists of a dry- and wet-bulb thermometer with a piece of wet muslin wrapped around the wet bulb. When the contrivance is whirled rapidly, the temperature of the wet thermometer is lowered depending on the amount of water vapor in the air. The relative humidity is then estimated by finding the difference between the temperature of readings on the two thermometers and consulting a table prepared by the weather bureau.

Next, a calibrated mecurial barometer was made. As the wind storm approaches, a sudden drop in atmospheric pressure is recorded.

At the right of the above gauge is a portable radio used hourly to warn the public. This proved very helpful in saving life and lessening property destruction.

Behind the mentioned aid is a simulated radar set which locates the disturbance. This instrument sends out electrical impulses, which upon contacting the storm, create echoes that are received by the radar antennae.

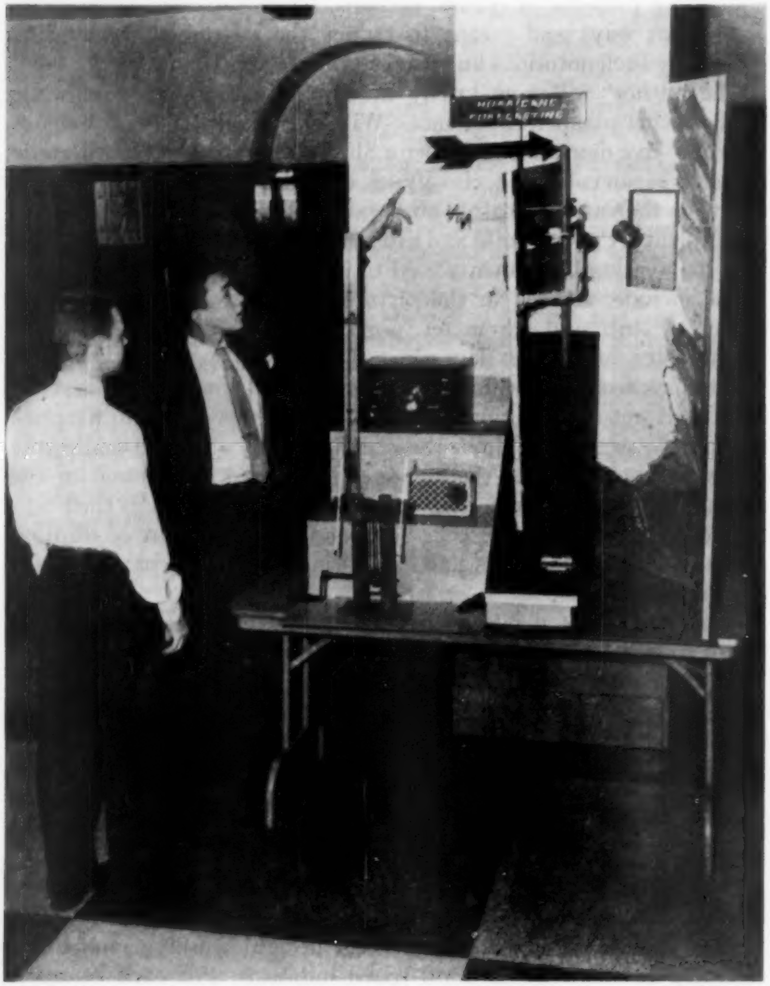
Next came the anemoscope or wind vane used to indicate wind direction.

Attached to the above device is an upright working model of a signaling anemometer or wind speed indicator. For each complete revolution a light flashes in a gadget at the base of the instrument.

[1] Many of Mr. Simmons' students have demonstrated their prize-winning projects before science-teachers' Societies and public gatherings, including radio and television.

By counting the number of flashes in a given time, the wind velocity for any direction can be measured. To rotate the four-mounted cups, an electric fan is placed behind the opening in the poster and across from the home-made instrument.

Two vertical red flags with black centers are behind the described contraption. These are displayed along the coast to forewarn the public of the impending danger.



Ross Photo Service

Glenn Shephard, Irving High School, a first-prize winner, explains his exhibit to a classmate, at the Greater Newark Science Fair.

For the background, an especially attractive, large-size poster partially surrounds the out-of-school project. The display illustrates the following stages of the approaching storm: a Hurricane-Hunter Plane traveling from Bermuda into the eye of the storm, a radar at Miami picking up the oncoming storm, a Miami radio station transmitting pertinent data to the United States Weather Bureau in Washington D. C., and danger areas displaying storm warnings received from our capital city.

To sustain student and community interest in science fairs, this potential young scientist demonstrated his organized project, over Station WRCV-TV, at a Kiwanis luncheon, and at our two-school assembly. At the latter occasion an industrial scientist, who had previously given assistance and loaned laboratory equipment to another one of our future scientists for a research project, pointed out that their efforts frequently lead to a rewarding career.

Our student body was then given a chance to view this and other long-range projects in the front lobby of our school. A picture of the exhibit also appeared on a television show over Station WATV.

Undoubtedly, one of the most important values of a student-centered experience of this sort, is that it gives a persistent youngster with a natural curiosity, whom we might call why-minded, an opportunity to carry on an extended investigation. This, in turn, affords an excellent stimulation toward a career in the ever-growing science-related occupations. However, the rate of scientific achievement can only be in proportion to the capacity of the young scientist's mind to search out and fathom new truths, to evaluate wisely, and to think creatively.

UNESCO PROJECT TO EXTEND PRIMARY EDUCATION IN LATIN AMERICA GETS UNDER-WAY

Latin America's desperate need for 400,000 school teachers was the prime concern of representatives of 12 Western nations who met in Havana, February 13, to set in motion the UN Educational, Scientific and Cultural Organization's program for the extension of primary school education in Latin America.

Thus, UNESCO has launched another of its "major projects" which are focal points in its overall efforts to promote international understanding and help solve problems in educational and other fields.

Delegates of the United States, Mexico, Haiti, Guatemala, Nicaragua, Colombia, Venezuela, Brazil, Peru, Bolivia, Argentina and Chile will serve as an advisory body to the staff charged by UNESCO with putting the program into effect. The Havana meetings mark the realization of an idea conceived at UNESCO'S General Conference in Montevideo in 1954.

Let us remember, please, that the search for the constitution of the world is one of the greatest and noblest problems presented by nature.

—GALILEO

ADVENTURES IN UNDERGRADUATE RESEARCH

JOHN R. SAMPEY
Furman University, Greenville, South Carolina

Statistical studies on the volume of current research in liberal arts colleges provides little incentive to engage in this most challenging of all teaching technics (1). Let a student, however, experience an exciting adventure in undergraduate research and he will need no other incentive to pursue a life-time of scientific research.

The terse, impersonal style employed in most scientific journals offers a poor medium for picturing the human interest story behind even the simplest discovery. At the risk of appearing dramatic we offer the following account of several explorations into the unknown which proved intriguing enought to the writer and the group of undergraduates who were assisting him in the investigations at the time.

An inviting field for beginners in research is the measurement of rates of chemical reactions, for it demands purification of all reagents, careful control of the many factors which influence the rates, and it offers a rich field for theoretical speculations on the interpretation of the data. In 1939–40 we were measuring the rates of bromination of a series of 26 substituted toluenes under the influence of light:

$$C_6H_5CH_3+Br_2=C_6H_5CH_2Br+HBr$$

We had obtained interesting differences in the rates of the photo chemical brominations of several ortho-, meta- and para-isomers, with close checks on duplicate runs, when suddenly the values jumped more than 25%. A check on the constant temperature bath, the source of irradiation, and every detail of our procedure showed that our only variable had been the use of a new five pound sample of reagent grade carbon disulfide. When a third sample of CS_2 was employed as solvent the values changed even more. When the two grades of solvent yielding the lowest rates were shaken with metallic mercury a black precipitate of HgS was formed. Vigorous shaking of these impure samples of "Reagent Grade" CS_2 with mercury, followed by redistillation, yielded a solvent which gave uniformly high rates of bromination of toluene. On the other hand, as little as 1/10 of a mg of free sulfur added to the reaction caused a definite decrease in the photobromination, while 1/10 of a g of sulfur blocked side-chain bromination completely The results of these studies on the negative catalytic effect of sulfur on photobromination appeared in two papers in the *Journal of the American Chemical Society* (2).

In 1940–41 a series of investigations on the rates of photochemical bromination of aryl methyl ketones began ignominiously. We were

unable to obtain checks within several percent on the rate of bromination of acetophenone, the simplest of the aryl methyl ketones:

$$C_6H_5-\underset{\underset{O}{\|}}{C}-CH_3+Br_2=C_6H_5-\underset{\underset{O}{\|}}{C}-CH_2Br+HBr$$

After dozens of trials trying to perfect our technic, we happened to let a weighed sample of the ketone stand several hours in an open Erlenmeyer flask before brominating. The slowness of the reaction gave us the lead that the samples were picking up some negative catalyst from the air during the weighing of the same. Acetophenone proved to be hydroscopic, and it was absorbing enough moisture from the atmosphere during the time of weighing to slow down the rate of photobromination. The study of the negative catalytic effect of water on the bromination was set forth in two more papers in *JACS* (3).

The most baffling of all our experiences in undergraduate reseach occurred in 1948–49 while measuring the rates of darkroom bromination of condensed ring hydrocarbons. We mixed equivalent quantities of phenanthrene and bromine, both dissolved in CCl_4, in a dark room, and after a given period of time the reaction was stopped by adding an excess of an aqueous solution of potassium iodide, and shaking vigorously the glass stoppered flask. The amount of bromination was determined by titration of the liberated iodine with sodium thiosulfate:

$$2KI+Br_2=I_2+2KBr$$

$$I_2+2Na_2S_2O_3=2NaI+Na_2S_4O_6$$

What was our consternation when we learned that the same amount of bromination took place in 5 seconds (the time required to add the excess KI solution and stop the reaction by vigorous shaking) as on standing 5 minutes. When the bromine and phenanthrene stood longer than 5 minutes there was a slow rate of bromination. We were unable to account for this seeming violation of the laws of chemical kinetics, and we presented the problem in a paper before the state Academy of Science. The only suggestion we received was the facetious remark, made privately, by a colleague in the state university, that we must be trying to mix chemical kinetics with Bapist doctrines!

On returning to our experiments on dark room brominations we secured a lead to the solution of the strange effects when we failed to add sufficient KI to remove all the bromine in the reaction flask. The excess bromine and liberated iodine thus remained longer in contact with the phenanthrene, and the bromination of the organic molecule proceeded very rapidly. In all our previous experiments the iodine could act as carrier for the bromine only for the few seconds

required to remove the bromine by vigorous shaking with the excess KI solution. With this clearing up of the mystery, there opened an interesting problem on the marked iodine effect in the dark-room bromination of condensed ring hydrocarbons (4).

As an epilogue it should be mentioned that all young participants in these adventures in undergraduate research have continued their scientific careers through graduate school into industrial research, except the two young ladies who are making homes for the scientists they met under these romantic circumstances.

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   b. SAMPEY, J. R. AND HICKS, E. M., *ibid.*, 62, 3252 (1940). "Side Chain Bromination. II. Negative Catalytic Effects."
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4. SAMPEY, J. R., MCCUEN, A. K. AND COX, J. M., *JACS*, 71, 3697 (1949). "Effect of Iodine as Carrier on the Rates of Dark-Room Bromination of Condensed Ring Compounds."

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note: Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

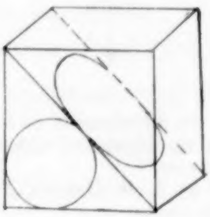
2539, 2540, 2541, 2543. *O. S. Narayana Swamy, Madras, India.*

2539, 2540, 2541, 2542, 2543, 2544, 2545, 2549, 2550. *C. W. Trigg, Los Angeles, Calif.*

2551. *Proposed by Hale Pickett, Redondo Beach, Calif.*

What is the radius of a circle, which is tangent to an edge of a one-inch cube, tangent to an adjacent diagonal of a face, and tangent to the circle formed by the diagonal plane of a one-inch cube cutting an inscribed sphere whose radius is 0.5 of an inch?

Solution by C. W. Trigg, Los Angeles City College



The diagonal plane of a cube cuts two opposite faces in diagonals. The circle cut by the same plane from the inscribed sphere is tangent to the aforesaid diagonals at their midpoints. So is the circle inscribed in the right triangle formed by the diagonal and two edges. Hence the radius of the circle is

$$1-\tfrac{1}{2}\sqrt{2}.$$

A solution was also offered by the proposer.

2552. *Proposed by Dwight L. Foster, Florida A. & M. College.*

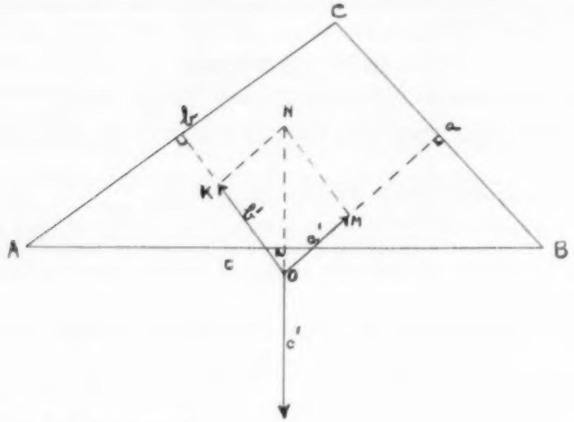
Forces act at the middle points of the sides of a triangle at right angles to the sides and respectively proportional to them. Show that if they act inwards or outwards, they are in equilibrium.

Solution by Charles H. Butler, Kalamazoo, Michigan

Since the lines of the three force vectors are perpendicular bisectors of the three sides of the triangle ABC, they are concurrent in a point O, and can be regarded as emanating from O.

Case 1: Forces directed outward

On the three force vectors originating at O lay off distances a', b', and c' such that $a':a=b':b=c':c$. On a' and b' as sides complete the parallelogram of forces $OMNK$. It is easily shown that $\angle OMN=\angle OKN=\angle C$, and from our hypothesis we have $a':a=b':b$. Therefore triangles OMN and OKN are congruent and each is similar to the original triangle ABC. It follows, then, that $\angle ONM=\angle A$ and $\angle NOM=\angle B$ (corresponding angles in similar triangles). Then since $OM\perp CB$, we have $ON\perp AB$, so ON and c' are collinear. Moreover, $ON:c=a':a$ by similar triangles, and from our hypothesis $c':c=a':a$. Therefore $ON=ca'/a$ and $c'=ca'/a$, whence $ON=c'$. Therefore ON (the resultant of a' and b') and the third force c' are collinear, equal in amount, and oppositely directed. Hence the system is in equilibrium.



Case 2: Forces directed inward

This would merely reverse the directions of all the forces, including a' and b', their resultant ON and their equilibrant c'. Otherwise the argument outlined above is valid in all details for case 2.

Solutions were also offered by A. R. Haynes, Tacoma, Wash.; C. W. Trigg, Los Angeles, Calif.; and the proposer.

2553. *No solution has been offered.*

2554. *Proposed by Brother Felix John, Philadelphia, Pa.*

In an equilateral triangle, the circumradius, R, is twice the inradius, r. Is the converse true? That is, if the circumradius of a triangle equals twice the inradius, is the triangle necessarily equilateral?

Solution by Alan Wayne, Baldwin, N. Y.

Yes, the converse is true. Let t be the distance between the incenter and circumcenter. Then, by Euler's formula,

$$1/(R+1)+1/(R-t)=1/r.$$

(See page 199, E. W. Hobson, *A Treatise on Plane Trigonometry*, Cambridge University Press, London, 1928; also, page 143, Levi S. Shively, *An Introduction to Modern Geometry*, John Wiley and Sons, New York, 1939.) Euler's formula may be re-written:

$$t^2-(R^2-2rR)=0.$$

Thus $t=0$, if and only if $R=2r$. Then the triangle must be equilateral, because a polygon which has a concentric incircle and circumcircle is regular.

We can extend this result: "A quadrilateral having an incircle of radius r and a circumcircle of radius R is a square if and only if $R=r\sqrt{2}$." For, in this case,

$$1/(R+t)^2+1/(R-t)^2=1/r^2.$$

(See Shively, page 159.) That is,

$$t^4-(2R^2+2r^2)t^2+(R^4-2r^2R^2)=0.$$

Since t is less than r, then $t=0$ if and only if $R=\sqrt{2}$.

It seems plausible that further extension is possible. That is, is the following proposition true?

Proposition: A plane polygon of n sides having an incircle of radius r and a circumcircle of radius R is regular if and only if $R=r\sec(180°/n)$.

Solutions were also offered by A. R. Haynes, Tacoma, Wash.; R. L. Moenter, Fremont, Nebr.; W. R. Talbot, Jefferson City, Mo.; and the proposer.

2555. *Proposed by N. Kacasamaiyer, Madras, India.*

ABC is a triangle; D and E are two points on AC and AB respectively such that $BD=CE$ and BD and CE intersect each other on the bisector of the vertical angle A. Show that $AB=AC$.

Solution by A. R. Haynes, Tacoma, Wash.

E, B, C, and D are concyclic since BC, BD and EC are chords of the circle O.

Draw FO, OG and OH perpendicular to BD and EC respectively. Then G, H are midpoints of chords BD and EC, and $OG=OH$ for they are equal chords from the center of circle O.

Therefore right triangle FOG equals right triangle FOH.

Then

$$GF=FH \quad \text{and} \quad BF=CF, \quad EF=FD.$$

Now O and F are equidistant from B and C; OF is the perpendicular bisector of BC at K.

Right triangle BFK equals right triangle FCK, therefore $\angle FBD=\angle FCB$.

Then

$$\text{chord } BE=\text{chord } CD.$$

Drop perpendiculars FL and FM to sides AB and AC respectively. Then since F is on the bisector of angle A,

$$LF=FM.$$

But

$$EF=FD,$$

therefore right triangle FLE equals right triangle FDM, and

$$EL=DM \tag{2}$$

Finally, in right triangles AFL and AFM, the hypothenuse AF and the acute angles at A are equal, therefore

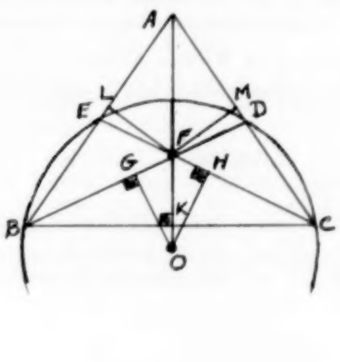
$$AL=AM. \tag{3}$$

Adding (1), (2), and (3),

$$BE+EL+AL=CD+DM+AM$$

or

$$AB=AC.$$



A solution was also offered by the proposer.

2556. *Proposed by Hugo Brandt, Chicago, Ill.*

The first six numbers of a series are

$$a_1=2, \quad a_2=3, \quad a_3=4, \quad a_4=11, \quad a_5=29, \quad a_6=62.$$

Find an expression for the general member $a_n=f(n)$; find the maximum a_n; find the first negative a_n.

Solution by Lloyd D. Olson, State Normal and Industrial College, Ellendale, N. D.

Assume that the desired function, $a_n=f(n)$, is a rational integral function of n. Then, if successive orders of differences are formed, eventually a series will be obtained in which all the terms are equal. Thus

$$\begin{array}{ccccccccccc} 2 & & 3 & & 4 & & 11 & & 29 & & 62 \\ & 1 & & 1 & & 7 & & 18 & & 33 & \\ & & 0 & & 6 & & 11 & & 15 & & \\ & & & 6 & & 5 & & 4 & & & \\ & & & & 1 & & 1 & & & & \end{array}$$

Now, since the terms in the fourth order of differences are equal, we may write,

$$a_n=f(n)=A+Bn+Cn^2+Dn^3+En^4,$$

where A, B, C, D, and E are constants which may be determined by letting n equal successively 1, 2, 3, 4, and 5, and then solving the resulting system of five linear equations. By this method we obtain the general term

$$a_n=f(n)=-\frac{1}{24}(n^4-34n^3+179n^2-338n+144).$$

It is easily shown that $f(n)=0$ has two imaginary roots, and two real roots. One of the two real roots lies between 0 and 1, the other lies between 28 and 29. Hence $a_{29}=-789$ is the first negative term in the series.

By the methods of calculus it can be shown that $a_n=f(n)$ has a maximum value (relative) for some value of n between 21 and 22. Hence either a_{21} or a_{22} must be the required maximum positive term of the series. By trial, $a_{22}=2018$ is the required term.

Solutions were also offered by V. C. Bailey, Evansville, Ind.; A. R. Haynes, Tacoma, Wash.; James Means, Stillwater, Okla.; R. L. Moenter, Fremont, Nebr.; W. R. Talbot, Jefferson City, Mo.; and the proposer.

PROBLEMS FOR SOLUTION

2575. *Proposed by Leon Bankoff, Los Angeles, Calif.*

Show that the area of a convex quadrilateral is equal to four times that of the triangle determined by the intersection of two opposite non-parallel sides of the quadrilateral and the midpoints of its two internal diagonals.

2576. *Proposed by Cecil B. Read, Wichita, Kansas.*

If σ is one half the sum of the medians of a triangle, prove that the area of the triangle is equal to:

$$\frac{4\sqrt{\sigma(\sigma-m_a)(\sigma-m_b)(\sigma-m_c)}}{3}.$$

2577. *Proposed by Julius Sumner Miller, El Camino, Calif.*

A sphere of mass M and radius r rolls down a plane of inclination θ in time t. The sphere is heated to T°C. In what time does it now roll down the plane?

2778. *Proposed by A. R. Haynes, Tacoma, Wash.*

Given the edges, and their inclinations to one another, of a parallelopiped.

I. Show the surface, S, equals $2(bc \sin\alpha + ca \sin\beta + ab \sin\gamma)$

II. Show the volume, V, equals

$$abc\sqrt{1-\cos^2\alpha-\cos^2\beta-\cos^2\gamma+2\cos\alpha\cos\beta\cos\gamma}$$

III. Show its diagonal, D, equals

$$\sqrt{a^2+b^2+c^2+2bc\cos\alpha+2ca\cos\beta+2ab\cos\gamma}$$

where the edges adjacent to the vertex, 0, are a, b, c, and the inclinations are c to b, α; c to a, β; a to b, γ. D is the diagonal from 0 to the corresponding opposite vertex.

2779. *Proposed by Cora Ritter, Montgomery, Ala.*

There are four trees standing, forming an irregular quadrilateral. How may 5 more trees be planted so that the 9 will form 10 straight rows with 3 trees in each row?

2780. *Proposed by J. W. Lindsey, Amarillo, Texas. (Especially for students of elementary mathematics).*

Derive

$$\sqrt{s(s-a)(s-b)(s-c)}$$

for the area of a triangle, where the sides are a, b, and c and s equals $\frac{1}{2}$ the perimeter.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2540, 2556. *John Wells, Plainfield High School, Plainfield, N. J.*

The Editor of this Problem Section is always happy to receive new and interesting problems for solution. Please submit problems to the editor.

BOOKS AND PAMPHLETS RECEIVED

GUIDES TO STRAIGHT THINKING, by Stuart Chase, Author of *The Study of Mankind*. Cloth. Pages x+212. 14×21 cm. 1956. Harper and Brothers, 49 East 33d Street, New York 16, N. Y. Price $3.50.

FUNDAMENTALS OF PHYSICS, Third Edition, by Henry Semat, Ph.D., *Professor of Physics, The City College of New York*. Cloth. Pages xii+914. 14.5×23 cm. 1957. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $8.00.

THE ORNITHOLOGISTS' GUIDE, Edited by Major-General H. P. W. Hutson. Cloth. Pages xix+275. 13.5×21 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 15, N. Y. Price $10.00.

PRINTERS' ARITHMETIC, by F. C. Avis. Cloth. 148 pages. 12×18 cm. 1956.

Philosophical Library, Inc., 15 East 50th Street, New York 16, N. Y. Price $4.75.

SECOND-YEAR ALGEBRA, INTERMEDIATE AND ADVANCED COURSE, by Herbert E. Hawkes, William A. Luby, and Frank C. Touton. Cloth. Pages viii+526+x. 12.5×18.5 cm. 1956. Ginn and Company, Statler Building, Boston 17, Mass. Price $3.16.

THE ENJOYMENT OF MATHEMATICS, by Hans Rademacher and Otto Toeplitz. Translated by Herbert Zuckerman. Cloth. 204 pages. 15×23.5 cm. 1957. Princeton University Press, Princeton, N. J. Price $4.50.

UNESCO SOURCE BOOK FOR SCIENCE TEACHING. Cloth. 222 pages. 15×23.5 cm. 1956. UNESCO Publications Center, U. S. A., 152 West 42nd Street, New York 36, N. Y.

CHEMISTRY FOR PROGRESS, by L. E. Young, *Professor of Chemistry, Mills College, Oakland, California*, and W. M. Petty, *Science Department, Fremont High School, Oakland, California*. Cloth. 590 pages. 14.5×22.5 cm. 1957. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.68.

FIRST YEAR ALGEBRA, by Walter W. Hart, *Author of Textbooks for Secondary Mathematics;* Veryl Schult, *Supervising Director of Mathematics, Public Schools, Washington, D. C.;* and Henry Swain, *Head of the Mathematics Department, New Trier Township High School, Winnetka, Illinois*. Cloth. Pages ix+390. 14.5×23.5 cm. 1957. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.40.

SECOND YEAR ALGEBRA, by Walter W. Hart, *Author of Textbooks for Secondary Mathematics;* Veryl Schult, *Supervising Director of Mathematics, Public Schools, Washington, D. C.;* and Henry Swain, *Head of the Mathematics Department, New Trier Township High School, Winnetka, Illinois*. Cloth. Pages ix+470. 14.5+23.5 cm. 1957. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.60.

MATH CAN BE FUN, by Louis Grant Brandes, *Encinal High School, Alameda, California*. Teacher Edition. Paper. Pages iv+200. 20×27.5 cm. 1956. J. Weston Walch. Publisher, Box 1075, Portland 1, Maine. Price $2.50.

A COLLECTION OF CROSS-NUMBER PUZZLES, by Louis Grant Brandes, *Encinal High School, Alameda, California*. Teacher Edition. Paper. Pages iv+226. 20×27.5 cm. 1957. J. Weston Walch, Publisher, Box 1075, Portland 1, Maine. Price $2.50.

ABOUT MICE AND MAN. AN INTRODUCTION TO MAMMALIAN BIOLOGY, by Frederick R. Avis, *Chairman of Science Department, Saint Mark's School, Southborough, Massachusetts*. Paper. 194 pages. 20×27.5 cm. 1957. J. Weston Walch, Publisher, Box 1075, Portland 1, Maine. Price $3.00. Ten or More Copies, $2.25.

SUCCESSFUL DEVICES IN TEACHING BIOLOGY, by Helen W. Boyd, *Covington High School, Covington, Louisiana*. Paper. 211 pages. 20×27.5 cm. 1957. J. Weston Walch, Publisher, Box 1075, Portland 1, Maine. Price $2.50.

HOW TO PROSPECT FOR URANIUM, by Hurbert Lloyd Barnes. Paper. Pages x+117. 13.5×20.5 cm. 1956. Dover Publications, Inc. 920 Broadway, New York 10, N. Y. Price $1.00.

ARITHMETIC TEACHING TECHNIQUES, by Joseph J. Urbancek, *Chairman, Mathematics Department, Chicago Teachers College;* J. T. Johnson, *Former Chairman, Mathematics Department, Chicago Teachers College;* Don C. Rogers, *Associate Superintendent, Department of Administration and Research, Chairman;* and Others. Paper. Pages x+363. 16.5×25.5 cm. 1949. Board of Education, 228 N. LaSalle Street, Chicago 1, Ill.

Educational Testing Service. Annual Report to the Board of Trustees, 1955–56. Paper. 150 pages. 15×22.5 cm. Educational Testing Service, 20 Nassau Street, Princeton, N. J.

Statistics of State School Systems: Organization, Staff, Pupils, and Finances, 1953–54. Chapter 2, Prepared by Samuel Schloss, *Specialist in Educational Statistics*, and Carol Joy Hobson, *Research Assistant*. Paper. Pages ix +141. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 55 cents.

On the Color of Coffee. by Angela C. Little, and G. Mackinney, *Department of Food Technology, University of California, Berkeley, California*. Paper. 12 pages. 15×23 cm. Publication No. 17, January, 1957. The Coffee Brewing Institute, Inc., 551 Fifth Avenue, New York 17, N. Y.

The Radio Amateur's Handbook, by the Headquarters Staff of the American Radio Relay League. Thirty-fourth Edition. Paper. 760 pages. 16×24 cm. 1957. American Radio Relay league, Inc., West Hartford 7, Conn. Price $3.50 in the United States, $4.00 in U. S. Possessions and Canada, $4.50 elsewhere.

An Introduction to Rubber. A black and white filmstrip consisting of 50 frames for use in grades 5 to 9, covering topics in natural and synthetic rubber, forms and uses of rubber in daily life and facts about the rubber industry; also a Teachers Guide to the filmstrip. Teachers may obtain both free of charge by writing to Teachers Library, Inc., 1790 Broadway, New York 19, N. Y.

The Microscopic World of the Moulds, a 10 by 20 inch multicolored wall chart depicting the microscopic organisms. Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y.

Encyclopaedia Britannica Films. Ocean Tides (Bay of Fundy), a 16 mm. sound film, 14 minutes. Dolls of Many Lands, 9 min. Bird Homes, 11 min. Available in color. Insect Life Cycle (The Periodical Cicada) 11 min. The Union of South Africa (Its Land and Its People) 17 min. Available in Color. Milk, 11 min. Keeping Clean and Neat, 11 min. Available in color. Our Post Office, 11 min. Available in color. Encyclopaedia Britannica Films, 1150 Wilmette Avenue, Wilmette, Illinois.

BOOK REVIEWS

A First Course in Algebra, by N. J. Lennes; J. W. Maucker, *President Iowa State Teachers College, Cedar Falls, Iowa;* and John J. Kinsella, *Chairman, Department of Mathematics Education, School of Education, New York University, New York City*. Cloth. Pages xvii+558. 14.5×23.5 cm. 1957. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.48.

A Second Course in Algebra, by the same authors. Cloth. Pages xix+476. 14.5×23.5 cm. 1957. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.80.

Probably the most important bit of advice that can be given to the students of algebra is to read carefully "A Talk with the Students," found on pages xv–xviii before starting Chapter I. These few pages of each volume are worth much in learning *how* to study and *why* it should be a part of almost every high school course. Following in Chapter I the language of algebra is compared with the language of arithmetic and an excellent start is made in the use of this new language. Then there is a review of the chapter. First with two sets of questions and exercises, A and B, then with special practice exercises, A, B, and C, graded for students of varying ability. This is the general plan of each of the 17 chapters of Book I and the 20 chapters of Book II. But right at the close of the first book

is a short review of arithmetic. This may be just the place to start your class. A few days here may clear up much instead of allowing some of your students to stumble along for weeks, tripping over little things they should have mastered back in the grades. You may frequently want to refer certain students back to these pages to clear up difficulties. Also near the close of each book will be found a short chapter on the history of algebra, which you may want to work in as you go along with the year's study. The first book closes the year with an excellent elementary chapter on quadratic equations and a chapter on indirect measurement and an introduction to the study of trigonometry.

A considerable portion of the beginning chapters of the second book is just a review of the work of the first year. Many classes will be able to cover this rapidly and spend most of their time on the new topics: Simultaneous equations in quadratics, progressions, logarithms, arithmetic and geometric series, indirect measurement making use of some geometry and trigonometry, the binomial theorem, permutations and combinations, probability and determinants. Teachers who have used the old Lennes algebra will want to see these new volumes put up by Professor Kinsella, aided by President Maucker.

G. W. W.

ATOMIC ENERGY, by A. Radcliffe, B.Sc., A.I.P., and E. C. Roberson, B.Sc., Ph.D., A.R.I.C. Cloth. 142 pages. 12×18.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

The recent trip of the nuclear-powered submarine *Nautilus* has shown us that the practical use of atomic energy is a reality of almost unlimited proportions. This book gives us the important steps in this wonderful development, omitting only the few items that are still top secret. The price of the book, nearly three and one-half cents a page, may seem very high, but it gives the information needed for a start in understanding many things now being developed, which will undoubtedly control much of the manufacturing, transportation, a great division of the medical profession, food preservation, and probably many other processes in the near future. About a third of the book tells of the discoveries, mostly in the half-century just past, that led to the harnessing of atomic energy. If you have no knowledge of this field of science, this section will require some study to acquaint you with some of the physics and chemistry used. A little science history in the discoveries of Hertz, J. J. Thompson, Rutherford, Curie and others is needed. Also the common energy terms such as photoelectric effect, Einstein's mass-energy equation, electron volt, M.E.V., etc. must be well grounded in your vocabulary. Considerable knowledge of the periodic table, and the way one element can be changed into another by fission or by combination is important. Some understanding of the construction and use of the great machines of recent years such as the cyclotron and bevatron, and the gigantic structures at Hanford, Oakridge, and Argonne comes into the picture. The final chapter gives a limited look into the future of atomic development. In a few places the text is marred by use of both English and metric units and the reduction of diagrams to such an extent that some parts are almost obliterated, but the book will give you a start in a field of unlimited promise.

G. W. W.

MATHEMATICS MAGIC AND MYSTERY, by Martin Gardner. Paper. Pages xii+176. 13×20 cm. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.00.

This is a book that tells you how to do the tricks and gives the explanation. Over 500 interesting tricks with cards, dice, and coins; demonstrations with pure numbers, geometrical tricks making use of triangles and squares; tricks with articles of clothing, handkerchiefs, rubber bands; magic with calendars, dominoes, watches, and matches. Some are old and some are so new that they have never appeared in print before. Here is fun for your leisure time, for your class, your family, and your club.

G. W. W.

MODERN HEALTH, by James H. Otto, *Head of the Science Department, George Washington High School, Indianapolis, Indiana.* Cloyd J. Julian, *Consultant in Health, Safety, Physical Education and Athletics for the Public Schools, Indianapolis, Indiana*; and J. Edward Tether, M.D., *Assistant Professor of Neurology, Indiana University School of Medicine, Indianapolis, Indiana.* Cloth. Pages ix+566. 15.5×22.5 cm. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.12.

Here is a book that could soon be recognized as a leader in the field of health education in the secondary school. The organization is so that whole units dealing with different phases of health may be studied or sections of each chapter may be used for pertinent information. The authors have given considerable space to a study of anatomy so that the working of the body can be understood in a study as to what can happen and prevention of things that may go wrong. Emotional and mental illness along with problems of personality are discussed. Factors that may contribute to these perplexing problems of the human being are discussed in an honest, forceful but interesting manner. The effects that come from undesirable use of alcohol, tobacco and drugs have on the human body are presented in an intelligent meaningful manner that should cause many students to carefully consider their use. Enough material is presented to meet the requirements of many states in the teaching about alcohol, drugs, and tobacco. Color, interesting pictures, and meaningful illustrations contribute and add much to the different sections of the book.

Those familiar with the new edition of Modern Biology will recognize a similarity in presentation of material and the general makeup of each chapter. Each chapter is introduced with an interesting paragraph. Each chapter ends with a group of words and short definitions to match, a few quick quiz questions and the suggested projects. The use of the "trans-vision" of the human torso is included. This is a valuable asset in the study of the structure and organs of the human body.

Each teacher interested in teaching of health and wanting a textbook in which students would be interested should look this book over.

NELSON L. LOWRY

DICTIONARY OF POISONS, by Ibert and Eleanor Mellano, Cloth. Pages 150. 1956. Philosophical Library Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

A small volume with information useful to anyone that at some time may find it neccessary to administer first aid to a victim of poison. A brief description is given of each poisonous material including history, origin and desirable use. In large type is found the name of the poison followed by symptoms, antidotes and first aid treatment. Each is presented in short simple understandable terms for immediate reference. This book is to be recommended as a valuable asset to a laboratory or worker that may find it necessary to help a fellow worker. As is stated at the end of most sections after first aid is given call a physician. However, what we do first may save a life.

NELSON L. LOWRY

THE PRESERVATION OF NATURAL HISTORY SPECIMENS, Edited and Compiled by Reginald Wagstaffe, and J. Havelock Fidler, M.A., Ph.D. Volume. One Invertebrates. Cloth. Pages xiiix 205. 18.5×25 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

A valuable source of information for those interested in preservation of Natural History specimens and as a source of information for others interested in Collections. The beginner should find it easy to follow the step by step method used in each chapter. The more experienced collector of specimens may want to vary from the technique described depending on the future use to be made of the preserved specimens. Included in the steps are methods of narcotizing, killing and preservation and mounting. Alternate methods are given for preservation of

various stages of development. This book should be an aid to the professional as well as a beginner for those interested in various specimens, but unfamiliar with methods of collection and preservation. Each chapter includes references to other articles and publications related to the preservation of specimens as discussed in the chapter.

Some of the processes and materials used may be unfamiliar to the student but with a little work and use of the appendix each can soon be understood. The appendix is a valuable part of the book. There are good illustrations used to illustrate special types of mountings in preparation of specimens. Most materials used and methods described are those used in the British Isles but are readily adaptable to specimens to be found in this country so there is little difficulty in using the book is better preservation of natural history specimens.

NELSON L. LOWRY

FUNDAMENTAL CONCEPTS OF HIGHER ALGEBRA, by A. Adrian Albert, *Professor of Mathmatics at the University of Chicago.* Clothbound. Pages ix+165. 15.5 ×23 cm. 1956. The University of Chicago Press, Chicago 37, Illinois. Price $6.50.

This book is designed primarily as a text in modern algebra. It could probably be used in a first course in the subject provided it is recognized that the material is presented in a somewhat compact form and would require that the instructor accompany the work with rather complete classroom discussions.

The usual topics concerning groups, rings, fields, and matrices are covered. The first chapter contains some of the basic concepts on which algebra is built, including assumptions, definitions, and notations. Ideas concerning sets, properties of integers, and basic notions about finite groups are included. The second chapter contains concepts of rings, ideals, fields, polynomials over a ring, and simple cases of the integral domain of ordinary integers and polynomials in one indeterminate over a field. Chapter three is an exposition of the theory of vector spaces, linear mappings and matrices. The fourth chapter is concerned with the theory of algebraic extensions of fields. As the author indicates, chapter five is the real reason for the book. A modern and improved exposition of the foundations of the theory of finite fields is considered. A brief list of references is included at the end of each chapter. However, chapter five has an extensive list of references to papers on equations in several variables over a finite field. Also included is a section on historical notes. Exercises are inserted frequently throughout the text. The lists of exercises, in general, are not comprised of great numbers of problems. This is not to imply that exercises are inadequate in any way.

Although there might be some hesitancy to recommend this book as a text for some of the more immature students, certainly it would appear to be usable in an introductory course in modern algebra with good students.

J. RAY HANNA
University of Wichita

INTRODUCTION TO THE THEORY OF GROUPS OF FINITE ORDER, by Robert D. Cormichael. Paper. xiv+447. 13.5×20.5 cm. 1956. Dover Publications, Inc. New York, N. Y. Price $2.00.

This book is an unabridged and unaltered republication of the first edition. The author introduces his text with a discussion of sets, systems, groups, permutations, isomorphism and related topics. The second chapter is devoted to five fundamental theorems of group theory. These theorems are rather basic to further developments in the subject. Additional properties of groups in general are developed in the third chapter. Theory of Abelian groups and prime-power groups is contained in the next two chapters. Some of the remaining chapters cover topics pertaining to permutation groups, abstract groups, and groups of linear transformations. An introduction to the theory of Galois fields is given in chapter nine. Chapters eleven and twelve contain an introduction to the

theory of finite geometries and collineation groups in the finite geometries. Algebras of doubly transitive groups of degree p^n and order $p^n(p^{n-1})$ is the heading of chapter thirteen. A final chapter contains a brief introduction to tactical configurations and groups characterized by them.

Included in this book is a large number of exercises, many of them immediately following basic discussions. Each chapter is terminated with an impressive list of miscellaneous exercises. The author suggests that more than 750 exercises are included, many of which are easy and intended for practice work on the part of the reader. Some of these exercises are results which the author indicates have never before been published.

It would seem that this book might well be used as a text for students who have the proper mathematical maturity. Certainly, it is a valuable source for exercises in the field of group theory.

J. RAY HANNA

ANALYTIC GEOMETRY, Second Edition, by R. S. Underwood, *Texas Technological College*, and Fred W. Sparks, *Texas Technological College*. Cloth. Pages x+280. 14.5×22 cm. 1956. Houghton Mifflin Company. Boston, Massachusetts. Price $3.25.

This book is designed as a textbook in analytic geometry. The usual topics of analytic geometry are included in this text; however, there are features of the book which merit special mention. General appearance of this edition is inviting. Figures are especially attractive and appropriate.

As pointed out by the authors, this revision contains several features not found in the original edition. Those articles which needed overhauling, as indicated by teaching experience and comment, have been rewritten. With minor exceptions, an entirely new set of exercises has been included in the first ten chapters. Partial revisions of the text have been made in many places, including the replacement of an article under the discussion of the parabola by a short separate chapter on "curve fitting." Considerable emphasis is given to the "art of sketching curves." Some rather novel features for rapid sketching are included. The idea of "degrees of freedom" along with the study of parameters and families of curves may have some merit.

Apparently, the authors have intended that this be a brief textbook, possibly best suited for a three or four semester hour course. Clarity, as emphasized by the inclusion of many illustrative examples, is a feature of the book. Comments are included frequently emphasizing usual points of student difficulties. Some of the points of theory have been developed in problems. Generally, problem lists appear adequate.

This book merits careful consideration by those who wish to select a text for a brief course in analytic geometry.

J. RAY HANNA

ADVANCED REAL CALCULUS, by Kenneth S. Miller, *Associate Professor of Mathematics, New York University*. Clothbound. Pages viii+185. 15.5×24 cm. 1957. Harper and Brothers, Publishers, New York, N. Y. Price $5.00.

This book is designed as a text in real variables, primarily for mathematics majors and beginning graduate students.

The development of the real number system is treated by means of Dedekind cuts with the assumption that the reader has some intuitive idea of natural numbers and rational numbers. The notion of greatest lower bound and least upper bound is based on Dedekind cuts. In connection with a study of point sets, the Bolzano-Weierstrass theorem and the Heine-Borel theorem are established. The concept of limit is treated rather carefully using the "δ, ϵ" method of definition and proof. Considerable space is devoted to a discussion of the Riemann Integral, including properties of the integral, integrability, the fundamental theorem, and mean value theorems. Sequences and series of functions, uniform convergence, continuity, differentiability and integrability of the limit function

and the special case of the power series are discussed. Functions of several variables are treated, including topics of continuity, differentiation and integration with these functions.

Proofs and illustrative problems, as well as counter-examples, are used freely. A list of exercises is included at the end of each chapter. There is an appendix which contains the solutions to some of the exercises.

It seems that this book merits serious consideration for those students who are interested in a careful approach to the introduction of real variable theory beyond a full year of calculus.

J. RAY HANNA

AN INTRODUCTORY COURSE IN COLLEGE PHYSICS, Fourth Edition by Newton Henry Black, *Assistant Professor Emeritus of Physics, Harvard University,* and Albert Payson Little, *Professor of Physics and Mathematics, Wayne University.* Cloth. Pages viii+786. 14×21 cm. 1956. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $6.75.

When a science book is revised, it indicates the publisher's faith that the book has a market and that the revision will improve the quality of the book. This physics text, originally published in 1935, was revised in 1941, 1948, and again with this 1956 revision. Upon examination, the reviewer can easily see why this would be a widely used text for the introductory course in college physics for those individuals not going on in physics. Such a group usually contains many individuals who have a fear of science and mathematics and take the course because it is required.

The text is simply written, but very clear and understandable. It uses many of the terms the student will find in the science articles in magazines and newspapers. It is organized around the traditional topics, yet includes the latest developments such as transistors, solar batteries, radioactive materials, mass-energy transformations, nuclear particles, and radar. The text is profusely illustrated with clear, purposeful line diagrams and pictures which contribute to the text. It consists of 49 chapters, none of which is over 25 pages long. At the end of each chapter is a concise summary and a list of questions and problems. This arrangement is an aid in using the book in a one semester course, as a chapter per session could be used by the lecturer and discussion groups. The development of formulas has been kept to an interesting minimum, yet formulas and their use are used throughout the text.

For a text as well written as this, it bothered the reviewer to find the confusing statements concerning the electron flow on pages 387 and 388. Ending a paragraph on page 387 is the sentence: "It has been assumed for many years that the current is a flow of positive charges in the wire from the copper to the zinc." Nothing more is said until 14 lines, 2 drawings and the next page concerning electron flow in the correct direction. Then, this sentence. "Since so much has already been written based on this older convention, we shall assume the direction of an electric current to be the direction in which positive electricity appears to flow in the conventional way."

This is a minor point, and if you are looking for an interesting, readable text for your beginning college physics course, you should examine this text.

E. WAYNE GROSS
University School
Bloomington, Indiana

AMPLITUDE MODULATION, edited by Alexander Schure, Ph.D., Ed.D. Paper. Pages vii+56. 14×21.5 cm. 1956. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $1.25.

This is one of the many books in the Electronic Technology Series edited by Dr. Schure and published by Rider, Inc. This is the first of the Communication Electronics group. The book discussed the process by which audio signals are used to modify the carrier wave of the transmitter. In amplitude modulation, the

amplitude of the carrier wave is varied as a function of the instantaneous value of the modulating wave. It discusses in detail with circuit diagrams and graphs the relationships of the functions of the waves. Many of the diagrams are similar to the patterns formed on an oscilloscope when used as a test instrument. The methods of modulation discussed are: plate modulation, control grid modulation, screen grid and suppressor grid modulation, and cathode modulation. The last chapter treats on the methods of checking and monitoring the modulated wave. Each chapter has six to ten questions at the end for checking and discussing the material in the chapter. This book would have value to a radio or electronics class. It would also have value for reference use in physics class and science clubs.

E. Wayne Gross

Blocking Oscillators, edited by Alexander Schure, Ph.D., Ed.D. Paper. Pages vii+64. 14×21.5 cm. 1956. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $1.25.

This is also one of the books in the Electronics Technology Series published by Rider, Inc. This is one of three in the series of six comprising the group concerned with oscillators and propagation. The other two which have been published are *Crystal Oscillators* and *Multivibrators*. This book has been written on a level for use by the advanced radio student or technician. The book consists of four chapters. These concern: (1) Description of operating features; (2) Popular description of operation; (3) Detailed description of operation; (4) Applications. Since it is fourth in the series, it assumes the reader has a knowlledge of oscillators and their function in electronic devices. However, the author very briefly, but clearly points out the difference between the wave produced by a blocking oscillator circuit and sine wave produced by the more commonly known oscillator circuits. As with the other books in this series, it has very complete diagrams and also drawings to represent the type of wave produced by the oscillator circuit. Each chapter ends with ten or more questions over the material covered in the chapter.

E. Wayne Gross

Coal-Mining, by I. C. F. Statham, M.Eng., M.I. Mon.E., F.G.S., *Professor of Mining, University of Sheffield*. Cloth. Pages xi+564. 22×14 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $15.00.

It is utterly amazing how so much information can be written in one book. And, it is equally amazing that such factual material can be presented in such an interesting manner. The book can be read as easily and with as much interest as any novel. Even though written in England, and primarily a description of coal-mining in that country, it is very true of our own underground coal-mining industry. This is a book which should be in every public school library.

The author states it is "a book which presents to the general public . . . an authoritative account of that vitally important industry. . . . " The first chapter deals with production of coal in England as well as the rest of the world. It discusses the uses and by-products of coal. The second chapter deals with origin and occurrence of coal. The information contained here would be of great value to science classes. The remainder of the 18 chapters deal with planning a mine, locating machinery, methods of working the coal face, transportation and cleaning the coal. It also deals with lighting, safety and ventilation of mines. Many of us in the United States oppose nationalization of industries, but it is enlightening to read the reasons for such nationalization and the effects of the same. Throughout the book are many excellent diagrams and illustrations to lend meaning to the many terms used by the mining industry. The book is expensive, but is worth it.

E. Wayne Gross

Arithmetic for Engineers, Fifth Edition, by Charles B. Clapham, *Author of Metric System for Engineers*. Cloth. Pages xiii+540. 13.5×21.5 cm. 1956.

John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $6.50.

It is all there. It is clear, concise, easy to follow, and remarkably understandable. Yes, this is true about Clapham's *Arithmetic for Engineers.* The whole field of practical mathematics is explained in such a manner that any student wishing to review his knowledge of mathematics may do so easily and without much lost motion. Students in the United States may find some words that might seem strange to them because the book was written by an Englishman. Some of the exercises may contain problems that are completely of English origin. This does not lessen the value of the book. In fact it makes it more interesting, for a student in the U. S. may find it amusing to work with "vulgar" fractions.

The book was not designed as a textbook for a beginner in the field of mathematics. It was designed as a book to be used for a review of all the mathematics that is needed by a student beginning his study of engineering. It is a book that should be introduced to all mathematics majors in high school, and should be on the bookshelf of every student going into the field of engineering. Teachers of mathematics will find it valuable as a reference.

A. PRYCE NOE
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INTERMEDIATE ALGEBRA, by Paul K. Rees, *Professor of Mathematics, Louisiana State University,* and Fred W. Sparks, *Professor of Mathematics, Texas Technological College.* Second Edition. Cloth. Pages x+306. 16×23.5 cm. 1957. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Price $3.90.

This is a text along traditional lines, neither the finest ever written, nor, by any means, the worst. The changes from the previous edition are relatively slight, for the most part the provision of a larger supply of problems. The problem supply seems ample to provide alternate assignments in successive semesters. A very good feature is the considerable number of notes or warnings to the student, cautioning against common mistakes. Some material is included beyond the level found in some intermediate algebra texts, for example: systems of quadratic equations in two variables, progressions, binominal theorem. Answers are in general provided for all problems except those with numbers divisible by four—some instructors may feel this leaves an insufficient number of examples without answers.

No text will please all readers. This reviewer found some points not to his liking. On page 2 an integer is a number used in counting—it seems possible to count by halves, i.e. $\frac{1}{2}$, 1, $1\frac{1}{2}$, etc., which might mean that a fraction is an integer. On page 132 law (4), dealing with exponents, omits the restriction $a \neq 0$. On page 234, if the definition given is accepted, logarithms of powers of 10 have no mantissas. Reasons why we must exclude division by zero seem unsatisfactory for the situation 0/0 (page 38). In common with many authors, it would seem that a graphical method of solution is not an algebraic method (pp. 111, 196); if so, why have it in an algebra text? On page 188 the sketch of an hyperbola is poorly drawn, as will be evident if one tries to draw asymptotes.

The objections cited are perhaps trivial; the book as a whole certainly merits consideration when a change of text is contemplated.

CECIL B. READ
University of Wichita

BRIEF ANALYTIC GEOMETRY, Third Edition, by Thomas E. Mason and Clifton T. Hazard, *Purdue University.* Cloth. Pages ix+229. 14×20 cm. 1957. Ginn and Company, Boston, Mass. Price $3.50.

This is a textbook of the traditional type. Possibly compared to the content of texts of a generation ago, it might be classified "brief," compared to some

recently issued texts, it might better be called "condensed." This is definitely a text in analytic geometry, not a combined analytics and calculus text or a text for a unified course. To the instructor desiring a text of this type, there will be a definite appeal. The treatment includes the usual second degree curves, the general second degree equation, including removal of the *xy*-term. Alegbraic and transcendental curves, parametric and polar equations, solid analytic geometry, spherical and cylindrical coordinates—these are all included.

Obviously opinions differ as to the merit of any book; this reviewer liked the use of the term "angle of inclination" rather than merely "inclination." In some cases it was felt the supply of problems was somewhat short, probably this is of importance if it is desired to use alternate assignments in various terms. Very rarely, in the illustrative drawings, is the scale used indicated on the axes (it is true, however, that coordinates of one or more points are shown, from which the scale can be readily determined). On page 78 the reviewer would have preferred the addition of some statement to indicate that if the particular equation given represents a graph at all, it represents a circle. As stated it would appear that all second degree equations of a particular type represent a circle. On page 161 the instructor may have to extend the remarks somewhat; it does not seem clear from the text that a point may have more than one set of coordinates in a polar system, and the fact that a particular set fails to satisfy an equation does not necessarily mean the point is not on the locus. The objectional points found were few in number, the book merits consideration when a change of text is in prospect. The review copy seemed to have some minor typographical errors in the footnote on page 54.

CECIL B. READ

ELEMENTS OF MATHEMATICS, by Helen Murray Roberts, *University of Connecticut*, and Doris Skillman Stockton, *University of Massachusetts*. Second edition. Cloth. Pages x+308. 18×26 cm. 1956. Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Price $3.50.

This text is planned for students on the college level who have taken no high school mathematics, or who need review. There are relatively few books written for this group, and this is a distinct addition. The general content might be described as covering approximately three semesters of secondary school algebra, and sufficient material from plane and solid geometry to enable the student to handle trigonometry and analytic geometry.

Certain features are very good; for example, although the text does not include problems involving angular measure in radians or in mils, the terms are mentioned. In general the treatment is rigorous. This reviewer liked the clear distinction made between ***exponent*** and ***power***. Illustrative examples are usually worked out in more detail than in most college texts.

The supply of problems is in general reasonably adequate, in some spots one might wish an additional supply, for alternate assignments. Scattered throughout the text one finds "Review Exercises" on pages apparently made to be detached. This means that if so used, each student will need a new text.

Some minor objections noted by the reviewer include: an unsatisfactory treatment of the reason for exclusion of division by zero in the case 0/0 (p. 19); an unusual juxtaposition of a multiplication sign and a negative sign (problem 28, p. 43); the omission of a condition that a base cannot be zero when stating laws of exponents (p. 133, p. 137, but correctly stated on p. 140); a peculiar statement on p. 247 (problem 18) that the government levies a 5% tax on each gallon of gasoline, and the state a 3% tax [the tax is in *cents*, not *per cent*].

CECIL B. READ

ARITHMETIC AT WORK, Book I, by Howard F. Fehr and Veryl Schult, D. C. Heath and Company, 1956. 410 pages, $2.80.

This text, as do most of the recent texts, uses figures and drawings, variations in type, and some color to illustrate and to emphasize concepts and processes.

It uses a good vocabulary for seventh grade children. The written problems are constructed about their scope of activities. It does not, however, follow the procedure used in most arithmetic texts of reviewing all fundamental processes before an introduction of new materials. The first chapter emphasizes the measuring of lines and angles. Fundamentals are included in so far as numbers are used in teaching this material. Chapter 2, entitled "The Art of Computing with Integers" follows through a substantial review of the arithmetical processes which deal with whole numbers. The chapters which follow set a pattern which alternates Geometry and Measurement with Arithmetic. The content of Book One is divided into the following sections.

1. Measuring Lines and Angles, The Art of Computing with Integers, and Geometric Forms (3 chapters)
2. The Use of Fractions, More About Measures, and Money and Decimal Fractions (3 chapters)
3. Per cent, The Circle and Geometric Construction, and Measures of Geometric Figures (3 chapters)
4. Per Cents in Use, Graphs, and Relations in Geometric Figures (3 chapters)
5. Comparison of Quantities, Economy, and Large and Small Numbers (3 chapters)

The treatment of materials within each chapter is complete. Additional emphasis for content understanding is arrived at in each chapter through a re-statement of concepts and relationships, a word list, a summary of facts, a set of review exercises and a test. The teacher who wishes something new in Arithmetic Texts will find this book worth examining.

WALDEMAR OLSON
University of Oregon

ARITHMETIC IN LIFE, Book II, by Howard F. Fehr and Veryl Schult, D. C. Heath and Company, 1956. 442 pages. $3.00.

This text is the second book in the 7th and 8th grade series. As in Book One, this text uses color, variation in type, size of figures and diagrams to emphasize and to facilitate developing the correct concepts. Each new process is carefully introduced with illustrative problems and with sufficient explanations to develop the concept introduced. This volume is clearly of a higher vocabulary, more thought provoking than Book One, but always within range of average 8th grade children in reading and general interests. Sufficient practice exercises follow to enable the students to assimilate the material presented. The content is divided into the following sections.

1. Measurement and Formulas, Understanding and Working with Numbers, Common Fractions and Decimal Fractions (3 chapters)
2. Measurement of Solids, The Meaning and Use of Per Cent, and Further Study of Per Cent (3 chapters)
3. Money, Credit, and Business, Saving, Wise Spending, and Investing, and Insurance and Taxes (3 chapters)
4. Ratio and Proportion, Geometric Construction, and Indirect Measurement (3 chapters)
5. The Use of Equations, More About Measures and Numbers, and Reading and Making of Graphs (3 chapters)

Cumulative reviews and cumulative tests are presented at the close of each section. Each volume has limited practice drills in the Appendix. This is another text worth examining if you are looking for a new approach to teaching Arithmetic.

WALDEMAR OLSON

CLASSICS OF BIOLOGY, by August Pi Suñer. Cloth. 337 pages. 13×21.5 cm. 1955. Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $7.50.

An excellent selection from the writings of men who are not only the mile posts of scientific progress but in many instances the signs pointing the way to new

concepts of biology. As classics in the field of scientific thought, their writings have become inspirations and guides to further progress. This is not a history in the usual, chronological sense; rather it is a series of separate résumés, each leading the reader through experimentation to discovery of new biological principles or concepts. The author beings out lucidly the struggle for the ideas we now accept without question while holding to the color and brevity which make books so readable. He is concerned largely with the events which resulted in the creation of each of several principles of biology, and he does not allow the diversions and side channels into which scientists have been swept to detour his presentation. In being so highly selective, any author opens himself to criticism for errors of omission, and Dr. Pi Suñer will undoubtedly receive his share.

A different biological principle is unfolded in each of the 16 chapters. The gamut of recent developments is covered from matter and energy and life to reproduction, heredity and speciation; from geography and paleontology to causation and design; from the whole to its parts. Much of its content is the old and the accepted, but some is so recent as to be maturing still. The book has value for the cytologist, physiologist, geneticist, ecologist, or philosopher. This is an opportunity for the specialist to refresh his knowledge and to discover the newer thinking in related fields of biology. This book is not to be read lightly as it contains background material for specific topics. Yet it should appeal to a wide range of readers from the layman with a passing interest in biology to the professional biologist whether he be high school teacher, medical man, university professor, or industrial biologist. Classroom use would be limited to senior and graduate seminars in the history and philosophy of biology and to use as a reference for the more serious high school student or college freshman in general biology. Originally written in Spanish, the book has been translated for this authorized English edition by Charles M. Stern who deserves much credit for retaining the spirit and detail of this fine work by Dr. Pi Suñer.

David H. Thomson
California State Polytechnic College
San Luis Obispo, California

Experiment and Theory in Physics, by Max Born, M.A., Ph.D., Sc.D.h.c., F.R.S., *Tait Professor of Natural Philosophy, University of Edinburgh.* Paper. 56 pages. 13×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $.60.

This is an expanded edition of an address given by the author in 1943. It is concerned with the interrelationships of experiment and theory. By the help of generous helpings from history he seeks to assess the priority of these aspects of science's on-going as regards each other. His concluding sentence brings his advice that "those who wish to learn the art of scientific prophecy (are) not to rely on abstract reason, but to decipher the secret language of Nature from Nature's documents, the facts of experience."

For the non-mathematical reader much of his attention to theory will be unintelligible. There are, however, many sections of rewarding reader-interest as he recounts specific instances of theory prompted empirically by experimentation or of experiments induced by the implications of theory's outreach. For those who wish to lift their attention to a broader more inclusive philosophy of physics this booklet offers pertinent and stimulating fare.

B. Clifford Hendricks
457 24th Avenue
Longview, Wash.

Encouraging Scientific Talent, by Charles C. Cole, Jr. Paper. Pages ix+259. 16.5×24.5 cm. College Entrance Examination Board, 425 West 117th Street, New York 27, N.Y. Price $3.50.

In 1928 a news release featured an American Chemical Society paper on "Finding and Salvaging the Superior High School Chemistry Student." That,

it seems, was a sort of harbinger of what has become a growing concern over the loss of *talent* during the transition of students from high school to college.

That 1928 paper was as "*one* crying in the wilderness"; the book under review, however, is the product of group cooperation. It is published by the College Board but was requested and supported by the National Science Foundation. It presents a "careful survey and research" including a "critical review of all existing literature in the field" supplemented by "a nation-wide study of United States high school sophomores and seniors regarding their college-going prospects and attitudes." This "study" was conducted by the Educational Testing Service by use of a "National Study Questionnaire."

The nine chapter titles give scrutiny to: Identification of scientific ability; Its supply and demand; Its loss in transit; Deterrents to scientific careers; Potential unused helps; Student attitudes toward college and scientific careers; and Scholarships as an encouragement. The author and his "Advisory Committee" provide a concluding summary chapter of recommendations.

For readers who care to probe for bases of those recommendations there are forty tables and figures; a twenty six page selective bibliography; three appendices and a four paged double-columned index.

Leaders charged with the job of arousing public attention to this nation-wide but neglected resource, here have help in the form of particularized referants to support previously over-used generalities. Every teacher of science and mathematics as well as all college, high school and public school administrators should, at least, scan its pages. By so doing they may become more intelligently aware of the seriousness of this need.

B. CLIFFORD HENDRICKS

EXPERIMENTS FOR MODERN SCHOOLS, The Science Masters' Book, Series III, Part IV, Edited by L. J. Rowse and R. J. Bartle. Cloth. 342 pages. 14.5×22 cm. 1956. John Murray Publishers Ltd. Albemarl Street, W. London. Price 15s. net.

The British science teachers make another contribution to Science Education in publishing this companion volume to previous collections of experiments and demonstration materials. There are more than 250 different selections from past issues of *School Science Review* classified according to the usual divisions found in American Physics texts. The number of Chemistry (20) and Biology (40) subjects are in the minority but are nevertheless of exceptional worth and would fit into the normal courses of study in this country. Miscellaneous items include methods of preservation and display, glass cutters, preparation of slides for projection, sterilizers, storage apparatus and construction of a soldering iron.

Descriptions are short, clear and well diagramed. The selections made by the editors are suited mostly for secondary science courses particularly those that might lack equipment and whose teachers must improvise for the benefit of the students. Most of the items could be constructed by intermediate students and some by upper Elementary science students. The materials required can be found in any laboratory or hardware store and most likely in any ten cent store.

American teachers will find a slight but interesting difference in terminology. In addition to the variety of new demonstration materials the book presents superior construction details and diagrams, as compared to most found in American Science Education journals. Content and purpose of the publication limits the use of this book but in so doing recommends itself as an excellent resource book for colleges of education libraries and personal libraries of General Science and High School science teachers.

JOHN D. WOOLEVER
Sarasota High School
Sarasota, Fla.

SCIENCE IN TODAY'S WORLD, by Maurice U. Ames, *Principal, Frank D. Whalen Junior High School, New York City;* Arthur O. Baker, *Directing Superivisor of Science, Cleveland Board of Education;* and Joseph F. Leahy, *Science Instructor,*

Herrick Junior High School, Cleveland, Ohio. Cloth. 280 pages. 17×23 cm. 1956. Prentice-Hall, Inc., Fifth Avenue, New York 11, N.Y. Price $3.32.

Departing slightly from the usual General Science text, this introductory book varies from the ordinary physical science emphasis and leans more towards the student as a living thing, his environment, and the most common important phenomena affecting his daily activities. Instead of the usual division into units of chapters, the material is grouped into six "cycles" each of which is divided into three "problems."

The first "cycle" integrates the scientific method and health problems both personal and public. This is followed by a study of foods, physiology, water, geology, astronomy and weather. There are short summaries, simple activities, review questions and references for further reading at the ends of the "cycles." The diagrams and photographs are not unusual but do illustrate important ideas in short appropriate titles. Frequently they may contribute as much as the pages of adjoining text if the teacher using them takes advantage of the opportunity. New and important words are italicized.

Content is primarily descriptive, as answers to proposed questions. Ideas and principles flow freely through the easy to read style that addresses the reader throughout.

One very short problem is devoted to the harmful effects of tobacco, alcohol and narcotics. The glossary includes a phonetic spelling and the index is exceptionally inclusive. One outstanding feature of the book is a map locating 131 Natural Science Wonders of the United States. Each "Wonder" has a short descriptive paragraph in a separate section of the book.

As a whole, the book is easy, accurate, up to date and if not adapted as a text should at least be included on the library science shelf. It allows for progress of the superior student while adequately providing for his average class mates.

JOHN D. WOOLEVER

THYROXINE, THE THYROID HORMONE

The pituitary gland has been called the master gland of the animal body. This is because—so far as science can show today—the pituitary hormones trigger production of other hormones directly responsible for body activity.

These other hormones include the sex hormones, growth hormones, and hormones produced by the adrenal glands, of which cortisone is an example.

Within the past few years scientists have taken a renewed interest in thyroxine, the thyroid hormone. They have found that here, indeed, is a substance that seems to play a part in nearly every function of the body.

Prof. Henry Lardy of the University of Wisconsin's Institute for Enzyme Research, along with Drs. E. C. Albright and Frank Larson of the U. W. Medical School have, in a sense, re-opened the subject of thyroxine, and they have made some interesting disclosures regarding what it is and what it is used for.

The thyroid hormone is a combustion control system of the human—and, of course, animal—body. The amount of thyroxine available determines the speed at which food burns and energy can be released for work by muscles and other tissues.

Wisconsin scientists are studying thyroxine from two aspects—its chemistry as a hormone and how it works its miracles in the body.

The Wisconsin scientists announced recently that thyroxine itself is evidently the raw material from which other hormones are made, and these, apparently, directly govern metabolism. Thyroxine must be converted into a substance named tri-iodo-thyronine before it exerts its effect on tissues. Tri-iodo-thyronine is often converted again into other substances before its tasks can be completed.

These discoveries—made by Lardy, Kenkichi Tomita, Frank Larson, and E. C. Albright—have raised the question: Are there many different thyroid hormones, or are they all steps along the way to the formation of one true hormone? There is as yet no answer to this.

MITOCHONDRIA

Within the cells of the human body—and of all other animals—lies one of the greatest of scientific mysteries.

The mystery is a chemical one, and when it has been unravelled man will have accomplished an enormous breakthrough in the task of understanding life itself—how it is made up, how it works, how it obtains energy from food.

Extremely small, oval-shaped cellular bodies named mitochondria are the chemical dynamos where oxygen taken into the body by respiration is used to convert food substances—the simple end-products of digestion—into energy.

Scientists have known for 100 years that mitochondria exist. Only within the last 10 years, however, have they found what mitochondria do. Today, the basic life processes they carry on are understood in outline; research, it is hoped, will reveal their exact chemistry.

One laboratory in which this research is being conducted is the Institute for Enzyme Research at the University of Wisconsin. Organized in 1948, the laboratory is one of few conducting research exclusively on the basic processes of mitochondria.

"Within mitochondria is to be found the complete machinery by which carbohydrates, fats, and proteins are ultimately burned to carbon dioxide and water, with the release of energy that life processes require," says David E. Green, enzyme chemist directing one of the Institute's two research teams.

Chemists once believed mitochondria to be tiny bags enclosing fluid in which floated hundreds of enzymes—each enzyme a distinct entity, each different, each separate, each performing a specific task. It was believed that these enzymes—life's chemical work-horses—performed tasks in a great and chaotic whirlpool of chemical action and reaction.

Then the Wisconsin chemists devised ways to shatter individual mitochondria. They found that each smaller piece could perform the same tasks as whole, intact mitochondria.

Only one conclusion could be drawn from this. Instead of a chaotic mixture of molecules, the chemists deduced, mitochondria must be an intricate mosaic, a composite of smaller, repeating units.

Next, the Wisconsin chemists shattered the sub-units into even smaller pieces. When this was done, basic functions of mitochondria began to show up. One kind of piece would do this kind of job; another piece would do another job.

Among these pieces, says Prof. Green, is one carrying on the process known as electron transfer.

"This process is known as electron transfer," says Green, "because electrons must be taken from foodstuff molecules and transferred through a series of receivers and finally handed off to oxygen.

"The first members in the bucket brigade of electron transfer enzymes is a flavin—one of the B vitamins. Following this are three enzymes containing iron. Undoubtedly, there are many yet to be found and identified," Green continues.

How do electrons move from one receiver to the next in line?

This, Green points out, is enzyme chemistry's biggest unanswered problem. Once answered, it may open the way to an understanding of mitochondrial architecture.

If, as now seems likely, electrons flow smoothly along the bucket brigade—rather than jumping—mitochondria must house a structural arrangement so complex as to stagger the imagination, Green says.

Experiment is the interpreter of nature. Experiments never deceive. It is our judgment which sometimes deceives itself because it expects results which experiment refuses. We must consult experiment, varying the circumstances, until we have deduced general rules, for experiment alone can furnish reliable rules.

—LEONARDO DA VINCI.

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